

## Chapter 2

# Related Work on Social Interaction and Social Simulation

Many sciences elaborate on SI and SS and discuss their aspects. Although these can vary much depending on the discussing science, a generic approach to prototyping SS systems must reconcile all of them.

Hence, the objective of this chapter is twofold. First, it gives an overview of existing approaches in SI and SS from the perspective of different disciplines and summarizes findings that will be considered in the proposed approach in the next chapters of this book. Second, it gives an inspiration for experiments in various sciences that can be performed by researchers in the field of SI.

Since existing approaches are not always easy to categorize exactly because of the semantic overlap of several sciences, for example, “Sociology”–“Social psychology” (sociology overlaps with psychology), the final categorization is met in favor of the most weighty discipline. Alternatively, since descriptions of certain related approaches, for example, in Straub et al. (2007), spread across related work in several disciplines, certain aspects of these approaches are discussed in several sections.

## 2.1 Sociology

Sociology explores societal peculiarities of SI (Turner 2011; Carbaugh 2005). For instance, sociology finds a definition of SI in the network society (van Dijk 2005; Castells 2005, 2009; Bondebjerg 2001; Hopper 2007).

The network society identifies particular entities of SI. The network society consists of organic and virtual communities where organic communities are the units that are typically considered as elements of a society—an individual, a household, a group, or an organization that participates in a face-to-face communication; in contrast, virtual communities are not tied to the particular time, place, or other physical condition and are loose affiliations of special interest, target, and discussion groups, for instance, on the Internet.

Drew et al. (2006) discuss social research methods in SI and emphasize the role of language in social experiments. Language stays in the focus of this discussion, and particular chapters of this volume present different aspects of its use.

Maynard and Schaeffer (2006) address in Chap. 2 standardization in interaction and use of survey interviews for this purpose. A survey interview is a questionnaire completed by an interviewer based on respondent's answers and can be seen as a form of SI. The authors state that survey interviews span "disciplines (especially psychology, political science, and sociology), national boundaries, government and business organizations, public and private sectors, and so on." Correspondingly, a survey interview measures "demographic characteristics" and aggregates "attitudes and opinions in many societies and subsocieties around the world" by sampling a population and estimating various characteristics of it.

Research suggests that standardization of interviews is necessary to avoid errors elicited by the interviewers. For instance, a standardized survey interview shows not only turns of an interviewer (IV) and a respondent (R) but also temporal details of speech delivery such as pauses:

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1  IV:  Generally speak^ing do you usually think of
      yourself as a
2      re^publican (0.4)demo[crat ] independent? Or=
3  R:      [republican      ]
4  IV:  =something else[:? re[publican? ]
5  R:      [      [republi  ]can
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In this survey interview, the upper arrow ^ presents intonation raise, (0.4) the duration of a pause, overlaps between utterances are indicated in brackets, contiguous utterances are linked by equal signs (=), question mark is a rising inflection, (: ) stretching of a sound. Hence, standardized surveys in SI and SS consider not only factual content, but also delivery aspects such as temporal.

Anssi Peräkylä discusses in Chap. 6 (Peräkylä 2006) how video recordings can contribute to understanding SI in a dialogue. These video recordings show, on the one hand, professional AIDS counseling and, on the other hand, everyday actions (greetings). The main objective of this ethnographic study is to show the gap between theories of practitioners and conversation analysis presented in the video recordings. The scholar concludes that mundane actions depend on the social status and emotional closeness of interactants what can be used in the study of SI.

Steven E. Claymann elaborates in Chap. 9 of Clayman (2006) on NL interviews and discusses the relevance of interaction. This chapter describes possible actions in the interviews such as eliciting a particular answer, but also tasks, norms, and constraints of journalists' questions must conform. The scholar concludes that news discourse depends both on societal institutions and on their relationships.

Fu and Zhang (2011) explore virtual worlds in the context of urbanization and address corresponding social aspects. The scholars show a framework that considers

social communication and personal opinions and describe a case study that distinguishes interpersonal interaction, behavior patterns, SI, and communication context. Another case study shows an approach to visualization of a virtual world that presents the infostructure of the virtual city under consideration of particular emotions and culture defined by Hofstede (2001).

Meister and colleagues (Meister et al. 2005) discuss SS in a Multi-Agent System (MAS) that maintains groups of agents and composes shift schedules of an organization under consideration of sociological preferences. The system acts according to capital sorts in the sociological theory of Pierre Bourdieu (1983, 1985) and performs negotiations between negotiation partners in a hospital. Partners' choice is strongly influenced by personal and typified experiences that can be defined, for example, by agents' personality and emotions.

Summarizing revealed findings in SI and SS, sociology distinguishes topology of SN, NL, relationships, emotions, context, MAS, personality, behaviors, virtual world.

## 2.2 Social Psychology

Poggi and D'Errico (2011) discuss SI in social psychology in the context of society and culture and argue that cognitive processes are influenced by social relationships and emotions felt toward another person. In scholars' opinion, SI depends not only on verbal but also nonverbal behavior and can be constituted by a computer and a human. SI can consider "social" emotions such as pride or admiration.

Berry et al. (2011), Shiraev and Levy (2006) pay careful attention to SI. They discuss behavior (including social behavior, psycholinguistical, and emotional) and present culture-related approaches to understanding it. Moreover, the scholars describe applications of these approaches to such domains as intercultural relations and communication, work and health giving serious consideration to the issues of SI.

The volume by Fiedler (2007) presents an overview of social communication and presents a framework that considers social relationship and domain knowledge. In Chap. 2, Kashima et al. (2007) point out that the today's globalizing world is affected by "clashes of civilizations" and there is a need for comprehension and mutual understanding on both sides of SI. Accordingly, SI proceeds in particular socio-cultural circumstances that correspond to certain cultural dynamics. In Chap. 4, Lucian Conway and Schaller (2007) provide evidence that communication is necessary and sufficient for culture representatives and describe cognitive issues of SI. In Chap. 13, Snyder and Stukas (2007) explore interpersonal processes in the context of settings and situations. They study how SI is influenced by contextual features and how expectations based on stereotypes and other category-based generalizations affect it. They articulate contextual variations and how these variations can change SI.

Straub et al. (2007) present a comprehensive study of intercultural communication and competence. They discuss basic aspects and definitions, disciplinary and

theoretical practices, methods, domains, applications, and approaches to facilitating intercultural competence.

In Sect. 2.10, Miller and Babioch (2007) state that all significant sociopsychological phenomena rely on communicative processes particularly in the intercultural context. They explore understanding of communication and state that consists of social cognition as a part of personal behavior and also of group-relations characterized through SI. Moreover, social cognition is so fundamental for a person that babies lacking communication suffer emotional, cognitive, and social impairments. Verbal and nonverbal signals of communication are influenced through culture-specific aspects.

The scholars discuss various aspects of SI such as interpersonal and intergroup communication. They underline coincidentally that intercultural communication cannot be only defined by personal issues of interactants such as self-conception, but is determined by a social environment such as a communication in a dyad or in a small group. Moreover, communication relies on situational constraints or on sociopsychological conception of others that should be considered in SI.

Friedlmeier (2007) explores in Sect. 2.11 approaches to cross-cultural studies and distinguishes four corresponding trends:

1. Homogeneity

Existing studies of cross-cultural differences assume a generalized structure of a culture with its norms, values, and behaviors. However, a more differentiated multilevel consideration is necessary.

2. Adaptability

Existing cross-cultural studies would benefit from empirical studies. For example, revealed cultural differences can be validated through interactive acquisition in a psychological context.

3. Completeness

A drawback of existing cross-cultural studies is their incompleteness according to the number of properties describing cultural groups, which complicates comprehension of considerable interdependencies. An important method of resolving this problem can be consideration of individual behavior in such studies.

4. Dynamics of cultural changes

In times of globalization, cultures are changing under influence of intercultural exchange, migration, demographics, etc. Hence, an approach to modeling such a change is necessary that considers theoretical models of these changes and changes of individual behavior.

The scholar overviews approaches to empirical acquisition of psychological properties at the cultural and personal levels. For example, he cites the work of Hofstede (2001), providing numerical values of five cultural dimensions in Costa and McCrae (1991). To measure these dimensions, the scholar follows Matsumoto et al. (2008), which explores differences in display rules of different emotions.

Helfrich-Hölter (2007) presents in Sect. 3.6 different approaches to experimental elaboration of SI. She discusses methodological settings of cultural experiments such as differential and generalization studies.

Differential studies explore the influence of culture on behavior where culture is defined through particular factors, for example, cultural dimensions in Hofstede (2001). In such studies, a particular task completion is supposed to be influenced by cultural aspects, for instance, identification of a semantic meaning of a word of a certain print color depending on collectivistic/individualistic culture of subjects.

Generalization studies explore how psychological interdependencies revealed in one culture are applicable to other cultures. To answer this question, generalization studies systematically investigate if particular experimental variables behave in the same manner in certain situations in all cultures. For instance, if similar situations induce similar effects on intercultural norms or intercultural competence. At the same time, the scholar discusses constraints of experimentation and methodological errors. To validate the studies, she explores its representativeness and considers such properties of subjects as education, dialect, demographics, etc.

Marinetti et al. (2011) study emotions in SI. The scholars present an overview of the SI research and argue that SI depends on social factors, for instance, on the relationship between interactants. They elaborate on SI differentiating between the face-to-face and video-mediated communication and consider the interactive context. Characterizing processes in SI, the scholars describe such behavioral patterns as mimicry or synchrony that can regulate interpersonal exchange. In conclusion, the authors state that natural interaction with humans must focus on dynamic models of SI that consider emotions not statically but dynamically. These emotions are influenced by the social and cultural context of SI.

Xiaomeng and Yue (2010) discuss psychology and micro-blogging in Twitter. Claiming that SI is influenced by micro-blogging, the scholars argue that micro-blogs can be seen as a representation of SI in that they propagate ideas and social dynamics.

Farrington-Darby and Wilson (2009) discuss findings in the work psychology using an example of a system for a rail network control. In their opinion, the success of controllers that maintain the system depends not only on technical knowledge but also on social skills and interactions. To perform their studies, the scholars rely on findings of ethnography and sociology that were obtained using such methods as interviews, surveys, and observations. The scholars conclude that although non-task-related SI plays an important role in task completion, SI is indispensable for passing task-related concepts and scenarios between team members. In future work, the scholars will explore the influence of SI on controllers' performance more exactly.

Birchmeier et al. (2011) present an interactive perspective of social psychology that focuses on the role of the computer-mediated SI. They recognize a powerful role of situation and social forces on behavior, thought, and emotions and acknowledge influence of personal determinants such as power and gender. Particular contributions of this volume take into special consideration certain aspects of computer-mediated SI and address trust, deception, and identity on the Internet as a consequence of developing relationships. The scholars present an international approach to computer-mediated communication, discuss leader emergence in on-line groups, explain exclusion in electronic-based interactions, and present the virtual

social world as a changing landscape of SI. To investigate SI, the scholars play the social game, Prisoner's Dilemma (PD),<sup>1</sup> known from the game theory (Myerson 1997).

Summarizing revealed findings in SI and SS, social psychology distinguishes topology of SN, situations, relationships, emotions, context, culture, personality, virtual world, and demographics.

## 2.3 Sociolinguistics

Linguists study SI.

In their volume, Fasold and Connor-Linton (2006) explore language and linguistics in the context of communication and discuss the corresponding aspects of analysis. They elaborate on linguistic SI and emphasize the role of sociology and communications. In her contribution, Schilling-Estes (2006) claims that language depends on different social factors and demographics as well as formality of speech situation. Moreover, she states that dialect plays an important role in communication since it describes cultural and personal distinctiveness. Tannen (2006) argues in her contribution the essential influence of cultural aspects on spoken communication and claims that contempt for corresponding influence can cause miscommunication or misjudgement. To convey her opinion, the scholar uses an example of communication between a German and an American and provides a detailed analysis of conversations taking into special consideration ethnic and regional aspects. Fasold (2006) studies the politics of language in the context of controversies of language uses and forms. To substantiate his findings, the scholar analyzes relationship between the language and the identity in China and Singapore under consideration of sociological theories. Moreover, he discusses issues of controlling the content of speech and explores reasons of blasphemy, cursing, or hate speech. In her contribution, Mackey (2006) discusses second language acquisition and analyzes how adults learn languages and what problems they are confronted with. The scholar argues that this acquisition relies on sociocultural background of each particular learner and demographical issues.

Pavlenko (2007) elaborates on multilingualism and brings together insights from different disciplines such as linguistics or psychology. She emphasizes the role of demographic aspects and communicative situations in analysis. Moreover, the scholar elaborates on reasons of code-switching<sup>2</sup> in SI.

Busch (2009) presents a survey of SI in linguistic research and claims that linguistic research lacks means to integrate the concept of culture. Thus, he explores cultural influences on SI systematically and confronts culture with psychological notions such as beliefs.

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<sup>1</sup>Prisoner's Dilemma is a conventional example in the game theory that introduces different variants of cooperation involving SI.

<sup>2</sup>*Code-switching* applies to switching between two or more languages in the context of a single conversation.

The study by Scollon et al. (2012) aims at comprehension of sociolinguistic issues in intercultural communication. Chapter 1 discusses the statement “culture is a verb” that emphasizes the meaning of actions in a culture. Chapter 2 elaborates on the meaning of discourse and raises questions about the discourse context, for example, about its grammar and culture. Chapter 3 introduces issues of interpersonal politeness and power and discusses communicative style in SI. It focuses on the paradox of face underlining an ambivalent tendency to present autonomy and at the same time to show involvement in groups’ events. Chapter 4 addresses communicational inference that explains inferential meaning, for example, in connection with verb forms or conjunctions.<sup>3</sup> Discussing implications of world knowledge, prosodic timing, etc., Chap. 5 draws on issues of topic and face. Consequently, it argues a special meaning of the culture and relationships stating, for example, that people in China, Japan, Thailand, or Vietnam are “quite conscious in any interaction” with others about their social, economical, and educational status.

Gumperz (1964) explores empiric aspects of SI, in particular, the verbal relationship between speakers, their cultural background, and the interactional environment. Accordingly, he distinguishes different verbal repertoires (linguistic forms) employed in SI: grammatical and social restraints on language choice. For example, interactants can consider certain style conventions and use “aren’t” instead of “ain’t”; social relationships and social occasions and use, for instance, “eat” instead of “dine” in the father–son relationship; co-occurrence restrictions and use, for example, “gonna” after “ain’t” and not “going to.”

Performing linguistic analysis of speech behavior, Gumperz discusses studies of Khalapur and Hemnesberget.

The study of Khalapur, an agricultural village near Delhi, India, begins with demographic, environmental, economic, educational, and political details. Social communities in Khalapur are called castes, and strict rules apply to interaction of particular castes with others, except close friends and family members. Describing the Khalapur verbal repertoire, Gumperz states that Hindi as a language of educated people (village leaders) symbolizes high-status relationships. In contrast, the dialect and standard Hindi are linguistic bounds of the verbal repertoire characterized through the simplification of grammatical and phonological constraints, for example, regarding grammatical function words such as pronouns.

Another study analyzes linguistic information in Hemnesberget (or Hemnes), a commercial settlement of 1,300 inhabitants, and Mo-i-Rana, both in the Rana Fjord of Northern Norway. Mo-i-Rana emerged in 1920 from a sparsely settled region in Europe with small farmers to an important iron and steel producing center in 1960. Accordingly, the region grew from 1,000 village inhabitants through immigration from South Norway to a city with 20,000 population with stores, hotels, and cinemas.

Hence, Hemnes verbal repertoire contains the village dialect and the literary, officially recognized standard. Despite the presence of the standard, Hemnes inhabitants prefer the dialect. Unlike its Khalapur equivalent, the dialect is used both

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<sup>3</sup> *Conjunctions* are grammatical items that are normally placed between two clauses such as *and*.

inside and outside geographical areas, whereas the standard is restricted to particular social relationships. There are grammatical (phonological) differences between the dialect and the standard, for example, regarding function words. It is noteworthy that although there is a traveling possibility between Hemnes and Mo-i-Rana, social events in Mo-i-Rana are of marginal interest for Hemnes' inhabitants.

Concluding his study, Gumperz compares speech variation and social relationships in Khalapur and Hemnes. Consequently, the verbal repertoires in these two regions are affected by semantic, grammatical, and phonological factors. Social implications and ritual barriers play an important role in SI. For example, a Khalapur villager obeys distinct rules of linguistic etiquette and requires special linguistic vocabularies, whereas a Hemnes inhabitant considers a limited number of social relationships in SI. Moreover, linguistic interaction in Khalapur and Hemnes is transactional and personal. Transactional interaction focuses on the socially defined goal, for example, religious service, whereas personal interaction emphasizes linguistic communication style of individuals.

Labov (2006) studies social stratification<sup>4</sup> of English in New York City and analyzes factors influencing SI. Consequently, he discusses problems and methods of analysis of English in social context, for example, linguistic interview that focuses on demographics of its respondents (age, race, religion, etc.). Moreover, he discusses variables of analysis in the social differentiation such as phonological (r) variable as determinant of socially related pronunciation. Subjective evaluation of variables is explored: The scholar discusses assessment depending on demographic factors such as age or gender. The vowel system of New York's inhabitants is examined in detail according to its class stratification.

Salzmann et al. (2011) discuss anthropological and linguistic issues of SI. Chapter 13 scrutinizes variations of communication according to the social class. It states that although native speakers speak the same language, the way of such speaking can be very different. For example, presidential speech differs very much from the speech of a retired woman. Considering language variation, they mention phonetic differences of speaking in the study of Gumperz (1964). The study of SI in Labov (2006) is also taken into account.

The scholars present their definition of SN. The connections between the interactants is regulated by roles (relationships). A particular role supposes certain assumptions about the meaning of messages. The researchers analyze gender-specific vocabularies and conclude, for example, that women use certain emotion words such as *fascinating* more frequently than men.

The scholars claim that languages are "seen as fundamentally very much alike but the social uses... are quite different from each culture to another." Hence, it is necessary to acquire *communicative competence*, the knowledge of what is being appropriate to say in a certain culture. Particular ways of communication are characteristic for a given speech community, a social group of persons of different

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<sup>4</sup>*Social stratification* defines in this case classification of English speakers into groups based on common socio-economic conditions.



demographic properties (gender, age, social status, etc.). The same persons can belong to several speech communities and adjust their pronunciation, way of speaking, etc. continuously during communication.

The scholars define the components of communication and distinguish between the sender of the communication message, its receiver, and the audience that can perceive the message. Consequently, communication is characterized by particular time, place, and physical circumstances. The scholars follow philosopher Hymes (1962), who states that communication settings can depend on psychological settings; communication takes place under identical physical setting, varying according to the mood of its participants. Communication is influenced by its purpose, channels, code, message content, and form. Moreover, communication is characterized by other components: genres, key, etc. An important aspect of communication are attitudes toward the use of speech. For example, those who talk freely are anticipated in the United States as self-confident, whereas Apache parents maintain complete silence when meeting their children returning from boarding schools. Since such communication components and peculiarities cannot be generalized, they should be studied separately in each concrete SI scenario.

Chapter 14 elaborates on linguistic anthropology in the globalized world and discusses intercultural communication and translation. Since people in the globalized world travel often and communicate with others from different ethnic societies and groups, cultural variation needs special consideration. Even if the guest and host languages are rather similar, semantic differences in linguistic comprehension should be still taken into account; otherwise, there can arise misunderstandings, for example, in relation with words that have the same vocable but different senses in various languages. For instance, the word “compromise” in American English has a positive connotation, whereas its connotation in British English is negative.

SI and the corresponding communication behavior in various ethnic groups can vary. For example, pupils can comprehend some expressions differently (Albert 1986), and teachers should be aware of this difference. Difference in communicative behavior can be formulated in relation to attitude toward communication. For instance, although Americans and Athabaskans (tribes living in Alaska and Northern Canada) speak only English, their communication behavior following (Scollon 1981) is characteristic of their ethnic background. Other issues can be also typical for ethnic communication. For example, Americans talk freely and communicate eagerly, whereas Athabaskans seem to be uninterested in such exchange and converse sparsely.

SI differentiates between different languages of politeness and law. For instance, the language of Chinese politeness distinguishes six terms of apology ranging from “simple regret” to request for “punishment.” Some languages manifest only law in talks, whereas American laws are all “written down.”

In conclusion, the scholars state once more that intercultural interdependencies became essential and understanding SI with representatives of other cultures is indispensable.

Summarizing revealed findings in SI and SS:,sociolinguistics distinguishes NL, context, culture, relationships, psychological settings, and demographics.

## 2.4 Anthropology

By definition, anthropology studies humans and their behavior in time and space. In this regard, SI in intercultural anthropology takes into special consideration temporal and geographic aspects of communication.

Koch and Mandl (2011) discuss geosimulation in urban processes and distinguish different tasks of simulation, for example, analysis of patterns of social organization or scrutiny of temporal or spatial processes. In his contribution, Koch (2011) discusses relationships of geosimulation in space, time, and social life. He elaborates on the question why spatial relationships are so important to understand geographical phenomena. König (2011) introduces a multiagent simulation that shows a city and socio-spatial organization of its population. The scholar claims that simulation allows empirical verification of properties of residential segregation or tolerance toward different kinds of residents or land or rent prices. Giffinger and Seidl (2011) state that simulation can be used to explore models of gentrification and give explanations for such phenomena as residential location or change. The contribution of Lindner and Hill (2011) discusses simulation of informal settlements or slums to study urban development in Dar es Salaam, Tanzania. In their opinion, simulation facilitates strategic and coordinated urban planning and is therefore a major challenge for urban researchers. Goetzke and Judex (2011) introduce a simulation of urban land-use change in North Rhine-Westphalia (Germany) and study aspects of urban growth. West and Deschermeier (2011) address residential satisfaction and claim that simulation identifies social clusters of urban place in social districts.

Aruka (2011) analyzes an approach by Glaeser and Scheinkman (2001) that measures SI via group selection. Accordingly, the approach distinguishes people that live in different cities, SI between them, and their culture and age. The approach assesses SI numerically by integrating it in utility functions that rely on monetary calculations.

Ioannides (2012) discusses SI in urban environments from the perspective of economics. The scholar describes in Chap. 2 theoretical models of SI and explores them in urban settings considering cultural and geographic dimensions. In Chap. 3, the researcher elaborates on decisions of individuals to choose neighborhoods or relocate considering educational and demographic issues. Chapter 5 presents location decisions in the urban space in the context of SI. Chapter 10 concludes that SI is fundamental in many aspects for the functioning of economics.

Brooks et al. (2011) analyze in Part III social and equity issues in urban economics and explore impact of SI in neighborhoods, drug wars, homelessness, poverty, racial segregation, assimilation, and gentrification. In Chap. 9, Ross (2011) studies how SI forms urban areas and discusses its educational, social, and economic aspects. He deduces implications of research on SI from these findings. In Chap. 10, Choi and Sloane (2011) raise the question if SI fosters crime deterrence. In their opinion, SI plays a significant role in “improving community dynamics and social relationships, even among people of difference backgrounds and income classes.”

van Baal (2004) introduces computer simulations for crime deterrence. In scholar’s opinion, computer simulations allow one to analyze individual, collec-

tive, and dynamic aspects of deterrence simultaneously. Moreover, SS enables researchers to follow a potential offender in an SN and to assess her/his evaluation of punishment and potential behavior. Hence, SS can oppose the benefits (pleasure) of crime and the expected costs (pain) resulting in the corresponding sanctions.

Rammert (2008) explores HCI and considers relationships defined by SI. He distinguishes interaction between human actors, intra-activity between technical agents, and interactivity between people and objects. In his exploration, the scholar claims a close association with anthropological concepts defined by SI.

Tangalicheva et al. (2010) discuss SI in the context of problems of acculturation in a big city. In their study, the scholars consider theoretical fundamentals of analysis, view a city as a space of intercultural interaction, and describe means of cultural coping.

Summarizing revealed findings in SI and SS, anthropology distinguishes space, relationships, demographics, time, and topology.

## 2.5 Learning

Learning is another field of study that considers influence of SI (Peterson et al. 2010; Schutz et al. 2010; Pane 2009).

Saleh et al. (2005) discuss SI in grouping arrangements in a plant biology course. The scholars analyze impact of groups on learning and differentiate between homogeneous and heterogeneous groups with students of high, average, and low ability. The experiments reveal that students of low and average ability benefit most from heterogeneous grouping since learning is influenced not only by abilities as such but also by SI between group members that improves learning results.

Peele-Eady (2011) discusses SI in developing identity of African American children claiming that this development often involves cultural and linguistic aspects. She elaborates on how language and interaction can contribute to socializing children and how the interplay between language and culture can be considered insofar. The scholar takes into account the communicative context (where and when communication activities take place) and pays particular attention to the intersection of what children learn and how this knowledge takes place in forming identity considering the role-relationships between interactants.

Umata et al. (2010) conduct a remote communication experiment that analyzes the influence of 3D images on SI in the music education considering emotions and social relationships. The experiment scrutinizes performance of students before and after watching a model performance by a teacher as a 3D image. Students (members of university orchestras) practice a musical piece in advance. In the experiments, students warm up and play the piece. Afterwards, a teacher (a professional violinist) perform the same piece projected on a screen without verbal comments, and the students can watch it on a display from the 30-cm distance. Afterwards, the students repeat their performance.

To assess the learning effect, students fill in a questionnaire that aims at assessing their emotional state. Moreover, the questionnaire evaluates respect for the teacher,

impression of the teacher's and student's own performances and nervousness while watching the teacher's performance. The revealed results attest that distant learning improves learning effect and can be therefore considered as a face-to-face counterpart of real learning.

Eggen and Kauchak (2012) argue following Vygotsky (1978, 1986) that SI facilitates children development. For example, children learn perseverance talking (interacting) with a mother. Moreover, children interacting with a more knowledgeable person can develop understanding that there are things they cannot acquire on their own. Knowledge of a culture accumulated over thousands of years should be reused through SI rather than reinvented. In scholars' opinion, students benefit from SI because it allows:

1. to acquire necessary information, for instance, while conversing (interacting) with other students;
2. to build own ideas, for example, because conversations (interactions) facilitate sharing ideas that can make a significant push into own ideas;
3. to put thoughts into words, for example, by verbalizing ideas in talks (interactions) and by substantiating own ideas.

Chen et al. (2008) studies SI in cooperative Web-based learning environments and proposes investigation of relationships in SN to find appropriate learning partners. Claiming that SI facilitates learning and consideration of social relations can significantly improve the learning effect, the scholars elaborate on the choice of beneficial learning partners that are assigned not by a human instructor but rather on the basis of SI.

The revealed results show high potential of the proposed approach. To calculate weights in the underlying weighted graph representing SN, the scholars assess the weight of the edge on the basis of information on initiating side of SI. For example, the weight of the edge  $R_{in(n)}$  is calculated as

$$R_{in(n)} = \sum C_{m,n}, \quad (2.1)$$

where  $C_{m,n}$  equals 1 if the  $n$ th learner actively interacted with the  $m$ th learner.

Thoms (2011) analyzes the impact of SI in academic blogging in large classroom environments and contrasts the instructor-driven learning with the student-centric learning. In the instructor-driven learning, the active role belongs to a human instructor, whereas the student-centric software emphasizes the role of a student and gives this student an easy possibility of providing feedback to the learned course.

The scholar proves two hypotheses: (1) A social feedback system for blogs positively impacts perceived learning;<sup>5</sup> (2) a social feedback system for blogs positively impacts perceived interaction.

223 students take part in the experiments. On average, the students compose five blog posts, give 20 ratings, 7.5 ratings' feedbacks, and 8.5 blog comments. To verify

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<sup>5</sup>Perceived learning characterizes student's perception of learning during a course, whereas actual learning can be measured using final exam scores.

the hypotheses, the Pearson's Product Movement Correlation Coefficient (PMCC)  $\rho_{X,Y}$  is calculated:

$$\rho_{X,Y} = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y}, \quad (2.2)$$

where the variable  $X$  corresponds to the frequency of system use, the variable  $Y$  corresponds to perceived level of learning; the function  $\text{cov}$  measures how much two random variables change together.

The obtained results assert that both hypotheses are true: the feedback influences learning and improves perceived interaction.

An approach of Nuankhieo et al. (2007) analyzes learning in online environments. The authors claim that online SI introduces new behaviors that are different from the one-to-one behavior between teacher and students in a typical classroom. Additionally, they argue that online SI considers context and culture in which it occurs and claim that new understanding of SI helps instructors to establish online learning. To evaluate their approach, the scholars distinguish SI in groups with 3–4 members or peer-to-peer activities. Consequently, the learning performance depends on sense of community, social relationships between peers, and demographic information such as gender or academic status.

Martinez-Reyes and Hernández-Santana (2012) describe a game, the Virtual Maze, that promotes teamwork and SI between children, motivates them, and effectively improves learning. For this purpose, the scholars develop a virtual world that represents a labyrinth in which the students have different social tasks: navigation that can need social collaboration if a student is lost; collaboration that demands cooperation with a guide that knows the way in the labyrinth; interaction where a student performs instructions of a guide to find the way. In conclusion, the researchers acknowledge usefulness of their studies and consider experiments with children from a primary school describing possible improvements of the game.

Spadavecchia and Giovannella (2010) present a project with online monitoring and evaluation of learning processes accompanied by SI. SI between interactants proceeds in exchange of NL emails or chatting. The project distinguishes eight macro-phases, the most important of which within the scope of this book are phases V and VI that collect data about the underlying SN and the social relationships between the learners. To assess the quality of an exchange, the emails or chat posts are scrutinized automatically according to their emotional content. Since revealed results are encouraging, the authors plan to develop in future work additional tools and methods for monitoring. Moreover, they consider implementing a real-time learning system that can be utilized on a daily basis.

Watson et al. (2009a, 2009b) discuss promoting prosocial behavior of groups of children in virtual learning environments populated by autonomous social agents. The scholars describe organization of human societies and present a simple SN as a model of a primary school class. The benefits of simulation are shown using the example of bullying that is used to develop copying strategies.

Watson et al. (2009b) outlines requirements for believable agents in learning environments. Hence, agents involved in SI

1. must be empathic to react to emotions of a counterpart appropriately;
2. must be endowed with the ability to communicate with other agents;
3. be alerted when a particular condition is satisfied; express emotions;
4. respond to emotions through different coping strategies.

To evoke empathy, three factors are necessary:

1. facial and body expressions;
2. situations' consideration;
3. proximity.

Summarizing revealed findings in SI and SS, learning distinguishes knowledge, space, context, relationships, emotions, demographics, culture, time, and topology.

## 2.6 Communication Studies

Researchers in communication studies elaborate on problems of SI (Gertsen and Sørderberg 2011; Kriyantono 2012).

For instance, Sorrells (2012) examines intercultural communication within the geopolitical, economic, and cultural context of globalization. The scholar discusses issues of culture and cultural space, elaborates on nonverbal and verbal communication, analyzes relationships in interpersonal contexts, and explores intercultural conflict and social justice. She describes problems of intercultural communication and strategies that play an important role in SI. Moreover, she presents clusters of cultures that define groups of similar cultures.

Andersen and Wang (2009) explore nonverbal factors of intercultural communication. Consequently, intercultural communication can be distinguished by chromenics, proxemics, oculistics, kinesics, haptics, physical appearance, vocalics, and olfactics. Additionally, the scholars discuss six nonverbal codes of intercultural communication including context, identity, power distance, gender, uncertainty, and immediacy. The *context* defines the vagueness of messages in cultural communication; for example, cultures with low context such as Swiss, German, or North American require explicit communication and specific details, whereas cultures with high context as China, Japan, or Korea get communication context from the physical context. The nonverbal codes correspond to Hofstede's cultural dimensions discussed thoroughly in Sect. 4.1.3: identity as the individualism/collectivism dimension, power distance as the power distance dimension, gender as the masculine/feminine dimension, and uncertainty as the uncertainty dimension. The immediacy code represents the disposition of representatives of a certain culture to more closeness, intimacy, and availability for communication. For example, cultures with high immediacy are French or Brazilian; cultures with low immediacy are Japanese, Chinese, and Korean.

Prepin et al. (2012) explore SI in the form of mutual stance defined as spontaneous expression of affect such as smiles in interaction with a person or a group of persons. Claiming that dyadic communication cannot be reduced only to speech but

considers many facets, the scholars consider such characteristics of comprehensible communication as gaze or prosody. The scholars introduce a model of mutual stances that differentiates two types of behavior alignment, interactive alignment and temporal alignment. Interactive alignment results in a combination of expressive elements, for example, mimics, facial expressions, etc.; temporal alignment stresses the role of temporal factors such as interaction protocols. In their study, the scholars elaborate on two types of smiles, polite or amused. To explore smiles, 192 videos of smiling virtual character and 348 videos of real persons of both genders of mean age 30 are collected.

The results of this study attest that a believable stance model should consider both types of alignment and rely on the internal state of the agent and on reactions of the communication partner. In future, the scholars plan to integrate more information about perceptive and motor spaces resulting in, for example, facial expression of anger. Moreover, they will add information about social relationships of the interactants such as friends or strangers as well as their personalities.

Bonin et al. (2012) explore temporal distribution and semantics of laughter as part of SI in conversation analysis. In their study, the scholars address questions concerning conversation patterns, topic changes, and topic termination: (1) can recurrent interaction patterns be identified in a conversation? (2) is laughter a reliable cue of topic termination? (3) does laughter mean changes in the information flow? To answer these questions, the authors use a multimodal corpus recorded at ATR in Japan containing 713 laughters in a conversation. A conversation can have several topics, and a laugh can be solo or shared with another interactant. The corpus is transcribed with start and end time of laughters' times. For the necessary lexical analysis, the Stanford POS Tagger is used (Toutanova and Manning 2000).

The results of this study reveal the following findings: (1) there is a higher probability to find a laughter at the higher distance to the topic boundaries; (2) the shared laughter is more likely to occur as the topic termination approaches; (3) shared laughter is more probable as an indicator of the topic termination although neither solo nor shared laughter alone are reliable indicators of topic termination; (4) the lexical variety<sup>6</sup> is significantly higher in the laugh termination segment compared with the laugh beginning segment.<sup>7</sup> Since this study could not provide exhaustive answers to the research questions, they should be tackled in further research.

Ojha and Holmes (2010) present a report on humor as a manifestation of SI in a small Midwestern US organization. In their study, the scholars use an approach of ethnography of communication<sup>8</sup> to understand patterns of communication in particular cultures. Claiming that humor has different functions such as positive (lightening tense moments) but also negative (teasing or hurting), the scholars elaborate on

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<sup>6</sup>The *lexical variety* of text measures the text variation that can be calculated as a ratio of unique words in text divided through the overall number of words.

<sup>7</sup>The *laugh termination segment* corresponds to the time span between the last laugh in a topic and the begin of the next topic; the *laugh beginning segment* is the time span between the first laugh in a topic and the begin of a topic.

<sup>8</sup>The *ethnography of communication* is an interviewing method that distinguishes interpersonal and intercultural relationships as well as social context and demographics.



qualities of humor and examine what role humor plays in organizational communication.

Over three months of study, the researchers collected four tapes of interviews and two memo pads with descriptions of moods and attitudes. This data has been transcribed, and the scholars extracted three topics of humor: everyday joking, superiority as sarcasm, and inclusive teasing. Stating that this study had “an element of surprise and freshness,” the scholars acknowledge its success since this study brought helpful insights into interpretation of SI on the workplace.

Summarizing revealed findings in SI and SS, communication studies distinguish NL, context, relationships, emotions, culture, and time.

## 2.7 Social Philosophy

Social philosophy explores philosophical questions of SI that concern, for instance, social conflicts.

Kincaid (2012) presents a comprehensive study of philosophy of social science. In the introduction, he addresses various questions of SI regarding significant advances, for example, in thinking about the social world, the conception of agents who act in the social world and agents’ autonomy, desires, intentions, and interests. In Chap. 11, Gelman and Shalizi (2012) show why philosophers consider probabilistic Bayesian models in SI. Kollman (2012) discusses in Chap. 15 computational models and their importance in philosophical discourse. Risjord (2012) argues in Chap. 16 how modern philosophers model a culture. Mallon and Kelly (2012) state in Chap. 21 a significant role of race in SI and state that “racial categories are not biological groupings but are rather social roles... sustained by cultural understandings, social conventions, and common practices of classification.” These social roles influence persons that “occupy them” and are psychologically constrained. Horwitz (2012) explores in Chap. 23 social constructions of mental illness and establishes a connection between a mental illness and minds, personalities, and brains. In Chap. 24, Woodward (2012) investigates empirical implications of cooperation and reciprocity from the philosophical perspective and considers social emotions such as justice, altruism in games, for instance, PD.

Honneth (1996) discusses SI in the form of social conflicts and discusses in Chap. 5 a theory of social recognition relying on emotions, rights, and solidarity. Accordingly, the scholar distinguishes recognition as an element of relations, an emotional respect in the form of needs and emotions, a cognitive respect in the form of rights, a social esteem in the form of community of value or solidarity. This theory differentiates additionally personality, relationships, relation-to-self, and forms of disrespect.

O’Neill and Smith (2012) investigate SI in the context of social conflicts and study connection between sociology and philosophy. Part III of this volume outlines the *recognition* notion that is explored in connection with politics, contemporary societies, and the state. In Chap. 8, O’Neill (2012) elicits relations between



Northern Ireland and England and substantiates the role of historical context in the ethno-national conflict. Moreover, he explains the individual freedom and the role of self-confidence, self-respect, and self-esteem that can be achieved only through relations with others. In Chap. 9, Owen (2012) studies issues of recognition in the context of dual nationality. For example, he claims that naturalizing into a new state means for an emigrant an emotional identification and simultaneously relations of value. Since migrants “typically identify with both communities” (the origin community and the residence community), the recognition acknowledges and “helps to sustain the distinctive relationship to this relationship.” In Chap. 10, Cox (2012) discusses recognition and immigration relying on the theory of modern societies in Honneth (1996). She recites important aspects of this theory and considers moral emotions such as love, respect, or esteem; social relationships, for example, family or friendship; context of SI given by demographic determinants such as origin, age, or function. Afterwards, she goes into adaptation of this theory regarding immigration practices and enumerates means of recognition. In Chap. 11, Heins (2012) elaborates on global politics of recognition and argues that only persons are “the ultimate means of moral concern” and not peoples or states. This discussion involves consideration of human feelings and human sufferings that accompanies the search for recognition.

Plant (2009) discusses different aspects of community as defined by the social philosophy, for example, community work as fact and value; individualism in community work; human needs and human nature. Accordingly, he discusses the notion of *whole man*, an actor in the community that has social contacts and roles. An individual in a community is characterized geographically and by the race to be seen as a social being (p. 72). Moreover, community influences individual’s mental health (p. 83).

Göller (2007) describes modern social philosophy not as eurocentric discipline but as a variety of cultures and traditions. Correspondingly, the typical philosophical questions such as questions of self or questions of thought should be debated only in a global context and consider possibly culture-independent knowledge, cognition, norms. In his opinion, only this perspective resolves many philosophical problems. Arguing his statement, the scholar presents an overview of previous philosophical approaches, including different findings not only by European philosophers, but also by Japanese, Chinese and Indian and points out social aspects of philosophical behavior. To explore particular issues in social philosophy, the scholar considers dialogue- and communication-oriented methods.

Summarizing revealed findings in SI and SS, communication studies distinguish emotions, relationships, culture, personality, and identity (self).

## 2.8 Neurobiology

Neurologists discuss SI to understand factors that accompany brain processes.

For example, Astolfi et al. (2011) describe a neurobiological approach that measures brain signals using Electroencephalography (EEG) during certain social tasks

**Fig. 2.1** EEG cap recording brain signals. Copyright free, image released into the public domain by Thuglas



(Fig. 2.1). The motivation behind this approach is that some goals such as tasks of SI cannot be achieved by separate individuals but only as a part of a group.

To provide a numerical evidence of SI, the scholars ask their subjects to perform social tasks. Since a human brain never performs the same task identically even under the same conditions, brain activities of several subjects in a group are recorded simultaneously during SI and not consequently. For this purpose, the proposed approach relies on EEG hyperscanning that defines a procedure of simultaneously measuring EEGs of multiple subjects.

The approach shows a particular interdependence between activities of different persons' brains that were engaged in the cooperation games. In opinion of the scholars, the obtained results open a new way of analysis of the brain functions and facilitate comprehension of brain activities. Moreover, the authors state that a shared feeling or a feeling of a group can be investigated comprehensively using the revealed insights.

Naeem et al. (2012) present another useful approach to studying SI in connection with EEG data. Hypothesizing that SI in dyads can share mutual information, the researchers study the behavior of 12 healthy persons that perform three social tasks in couples: (1) couples try to make own finger movements while ignoring partner's movements; (2) couples try to synchronize their finger movements; (3) partners try to syncopate their finger movements. Using an analytical approach to depict brain information, the scholars show mutual EEG information in 60 brain regions. They conclude that particular SI tasks can lead to activation of specific brain regions.

Knoch et al. (2008) explore SI in larger groups of interactants (5, 10, 20 people) and study cognitive functions of interactants under electric stimulation of particular brain regions. The scholars describe prior experience in this field and discuss exper-

iments on brain activity that examine the social behavior of interactants regarding social emotions such as altruism, suspect, and doubt.

To elaborate on interdependences between social behavior and brain activity, the scholars discuss results of a social Ultimatum game. The game setting is similar to PD and measures the activity of prefrontal cortices.<sup>9</sup> The rules of the game are the following. An interactant pair, a proposer and a responder, should split an available amount of money. The proposer makes a fair or unfair offer on how to split the money. The responder can accept or reject an offer. If the offer is accepted, the money is split as offered. If the offer is rejected, both players earn no money. Hence, the proposer chooses the amount of money that a responder can earn, and many responders are torn apart between economic interest and unfairness considerations. The scholars study the acceptance rate and draw their conclusions on how fairness/unfairness in SI influences responses in their experiments.

In other experiments, participants in the age between 21 and 26 (the mean 23 years) play the game that splits the sum of 20 Swiss Franks (CHF) in 4, 6, 8, 10 CHF offers. 128 players are proposers, 64 players are responders, and they receive either active electric brain stimulation for the whole period of the experiment or only placebo stimulation that stimulates the brain only first 30 seconds.

The scholars examine revealed results according to the stimulation method (active or placebo). It is worth noting that in the active stimulation the acceptance rate of the most unfair offer (4 CHF) is 46.6 %, significantly higher than 25.4 % in the placebo stimulation. Concluding, the scholars claim that consideration of social factors such as fairness judgements strongly influence neurobiological SI experiments.

Anderson and Dickinson (2010) discuss a neurobiological experiment regarding decision making in social exchange in sleep deprivation. In particular, the scholars are interested in how neurobiological experiments influence the judgment ability in SI. The authors state that decision making in general is regulated by emotions and present a survey of approaches that link emotions and brain regions. To obtain experimental results, two games with financial incentives (the Ultimatum game described above and the Dictator game) and a trust game are proposed that examine fairness, trust, and trustworthiness in SI. Additionally, the games study a conflict between personal financial gain and a payoff equality focusing on decision making under conditions of sleep loss where two anonymous partners try to avoid an unfavorable inequality. The revealed results state that SI is influenced by such processes as decision making or emotions.

Summarizing revealed findings in SI and SS, neurobiology distinguishes emotions, groups, and context.

## 2.9 Medicine

Physicians discuss the influence of SI on human health.

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<sup>9</sup>*Prefrontal cortices* are brain regions lying in front of the brain that are said to reason psychological functions of an interactant such as decision making.

Rossier and Bernardi (2009) study biological, psychological, relational, and social reasons for fertility intention<sup>10</sup> and analyze the gap between the fertility intention and fertility behavior. They argue that this gap can be explained by the role of individuals in SNs, i.e., is influenced by SI. To prove their hypotheses, the scholars discuss different aspects of social and demographic properties of their respondents.

Fritz et al. (2011) discuss treatment of drug-dependent individuals. The scholars claim that the most significant problem of the drug treatment is reactivation of interest in non-drug-associated activities. To cope with this problem, the researchers explore an important role of SI that would ease drug dependence.

Poutvaara and Siemers (2008) study connection of smoking and SI relying on insights from social psychology and experimental economics. The scholars analyze SI in smokers' and non-smokers' behavior and establish a model that considers utility of smoking and its loss. They perform experiments using games that give social norms special consideration. For example, an experiment studies a rule that smoking exceeds utility from SI when smoking is a social norm.<sup>11</sup>

Cutler and Glaeser (2007) analyze reasons of smoking and study their influence on SI on smoking behavior. The scholars identify reasons of smoking such as marriage with a smoking spouse or education and examine the dependency on demographic factors, for instance, on age or on race.

Lis and Bohus (2013) explore factors that influence SI of the patients with the Borderline Personality Disorder (BPD). Analysis of core domains of SI (social affiliation, cooperation, and hostility) reveals that patients with BPD experience typical problems of impaired social behavior: they misinterpret social situations, erroneously feel social rejection, or have difficulties in repairing cooperation. The scholars conclude that treatment of BPD should consider training of desired behavior.

Tsai and Lin (2011) describe a game-based learning approach for children with Autism Spectrum Disorder (ASD). Since ASD children have medical difficulties concerning social behavior, emotional behavior, and emotional feedback, the scholars present an approach to overcome these difficulties using an interactive game, FaceFlower, that helps autistic children to learn to convey facial expression of emotions in the context of social scenarios. The goal of the therapists that treat the ASD children is to help children to establish social relationships with other peers.

The task of the game is to complete gardening construction with peers in the limited time. The game relies on an engine that recognizes facial expressions of children that play the game. Evaluation of the approach is provided by seven experts that positively assess the game and make propositions on further improvement.

Alcorn et al. (2011) suggest an approach to treat children with ASD. The children are confronted with a virtual environment based on a touchscreen showing a virtual character that can point to an object. The ASD children practice SI when the virtual character gazes at the child and/or point to an object on the screen treating

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<sup>10</sup>*Fertility intention* defines the wish to get a child.

<sup>11</sup>*Social norm* is a standard behavior in a human society that determines, for example, whether smoking is accepted or not.

ASD using a virtual environment. The scholars claim that virtual environments are a promising method of the ASD treatment since exercises can be practiced repeatedly. They conclude that obtained results are highly encouraging.

The approach of Ono et al. (2012) clarifies the relation between SI and mental health of members of an SN. The scholars investigate data of a consulting firm with 136 members and a care home with 50 members that were asked to fill in a questionnaire about their mental health. The questionnaire contains inquiries about the respondent's well-being including psychological, social, or physical factors.

The approach collects face-to-face data using wearable sensing devices in two Japanese organizations and analyzes the strength of relations considering SN centrality, SN topology, and duration of SI. SN centrality represents connection strength between interactants and is calculated using physical proximity between them, number of contacts, duration of SI, etc.

The approach found statistically significant negative correlations between stress measures and individual mental health, meaning that interactants, especially the elderly ones, spending more time in SI have less stress.

Moreno et al. (2012) introduce an annotation scheme for medical SI games that borrows findings from psychology. Since following (Guralnick et al. 2006) playing can show irregularities in children's behavior such as autistic behavior, the scheme contains three main categories that cover SI, physical activity, and the relation to the phase a child is in (indication of how simple the game is and if the child will play it).

The scholars perform playing experiments with 39 children where an interactive playground consists of a projector, a camera, wireless motion sensors, etc. The playing is filmed and annotated by four annotators according to the proposed scheme. The scholars conclude that the proposed annotation scheme can be used to annotate SI in future experiments.

Kandroudi and Bratitsis (2010) discuss treatment of patients with Asperger Syndrom (AS). People with AS do not have problems in their cognitive development but rather drawbacks in social skills that are usually manifested through loneliness and anxiety. Hence, patients with AS can benefit enormously from the computer-mediated treatment since as the authors state it enhances development of autonomy, encourages communication, boosts self-confidence, and reinforces optimism and respect. Moreover, only SI in computer-mediated systems offers safety to autistic people that would be otherwise considered as a threat. The scholars describe a project with computer-mediated asynchronous discussions where interactants (students) can practice their social skills. The project studies two research questions: (1) can a student with AS be involved in a meaningful interaction with other students and improve social skills? (2) if an improvement occurs, is it permanent or temporarily?

The project distinguishes three stages. In the first stage, 27 students are familiarized with journalism-related concepts such as international news. In the second stage, each student is assigned the role of a journalist. The third stage is computer-mediated where students discuss an electronic newspaper and can comment different articles in discussion forums. The time of comments and discussions is restricted:

students can only access the asynchronous discussion forum locally, twice a week, to omit influence of students' parents.

The project reveals the following answers to the research questions. (1) The obtained results attest considerable improvements of social skills—a student with AS was one of the most active students and communicated with many of his peers. (2) Although the student with AS is overwhelmed with feelings of happiness and is noticed to be more social in breaks, this improvement was completely temporary. The authors conclude thus that although project results are quite promising, more research is necessary. For example, it is necessary to study means of making improvement of social skills permanent. The other interesting aspect that can be studied in future is an adjustment of completely asynchronous discussions in synchronous collaborations in chats, which would increase psychological pressure on the patients and can have beneficial influence on the treatment.

Klein and Cook (2012) discuss emotional robot therapy in connection with the treatment of patients with cognitive impairments (dementia) in UK and Germany. The authors study how SI in care can be improved by robotic intervention. Since dementia patients often experience social and emotional isolation, the research aims to enhance care by mimicking emotional expressions and gestures using SI in emotional robots. In conclusion, the scholars state that a therapy based on SI can significantly enhance quality of life for dementia patients.

Adams and Robinson (2011) describe a project that addresses children with Autism Spectrum Conditions (ASC). Similarly to ASD children, children with ASC have difficulties with SI that can be treated using a game maintaining facially expressive android heads that follow particular strategies. In this game, a head imitates an emotion that should be mimicked by a child with ASC. Simulating emotions, the child learns to observe, control, and imitate emotions. To evaluate the approach, children with ASC are asked to label seen emotions. In conclusion, the researchers evidence encouraging results that should be considered in future.

Summarizing revealed findings in SI and SS, medicine distinguishes emotions, space, time, emotions, relationships, and topology (SN).

## 2.10 Social Robotics

SI is an emerging field of research in social robotics that investigates interaction between robots and humans (Murray et al. 2009).

Cangelosi et al. (2010) present a position paper that discusses trends of developmental robotics and addresses, among other things, social and communicative skills of robotic agents. The scholars state that embodied cognitive agents (e.g., robots) should be endowed with the ability to collaborative handling of objects, with the ability to learn aspects of interaction with other agents/environment, and with the ability to develop/transfer the skills by sharing them with other agents.

Williams (2012) discusses SI in the context of key cognitive capabilities of robots and claims the necessity of social intelligence to foster effective collaboration with

people. Robots should display their cognitive states such as pleasure to be considered by humans as intelligent and be accepted. Moreover, an important cognitive capability that would improve human acceptance is the skill to predict and to explain human actions and behaviors.

Fink (2012) presents a literature overview and presents guidelines of design of social robots. Correspondingly, a social robot in Human–Robot Interaction (HRI) should be *anthromorphic*, meaning that it has to be humanlike to be accepted by humans. This similarity relates not only to robot appearance, but also to its behavior. Hence, enhancement of SI makes HRI more natural and therefore more effective. The behavior should be multimodal and consider gestures and emotions.

Dragone et al. (2005) present a framework that defines means to study SI between social robots, robots, and humans. The framework integrates physical robots, social robots, and humans in a shared social space participating in SI. Evaluating their approach, the scholars develop a computer system, a MAS, that relies on a Social Robot Architecture that combines the Belief-Desire-Intention (BDI) agents (Rao and Georgeff 1995). A reactive behavioral system and a social architecture allow exchange of the Foundation of Intelligent Physical Agents (FIPA)<sup>12</sup> messages. Social robots possess an identity that is characterized by the *character* of a robot and the *stereotype*.<sup>13</sup> To debug the MAS, the developers use a workbench with a BDI debug window and a BDI property window.

Gockley et al. (2005) describe an approach to designing long-time robots that consider SI in their actions. Their robotic roboceptionist, Valerie, communicates with visitors and shows an expressive computer-animated face. The roboceptionist is equipped with a Liquid Crystal Display (LCD) screen and a scanning laser that detects individuals moving around (Fig. 2.2).

Figure 2.2 shows the roboceptionist Valerie. The robot has a character and a personality and interacts with the users by maintaining a keyboard input that is processed by a rule-based NL engine. In opinion of the researchers, Valerie attracted visitors over nine months and can be improved by considering knowledge from human–human SI. Moreover, in future work the scholars recommend integration of more visitor identification and personalization as well as of more visibility of robot's emotions.

Pacchierotti et al. (2006) address design of a SI robot that guides passage behavior of visitors in an office. The scholars state that studies of different passage behaviors can foster research in SI. The tasks of the robot is detection of the visitor entry and offering the guide assistance. The robot maintains a module that functions according to a certain passing strategy considering 3D space and collision avoidance.

Sabanovic et al. (2006) introduce results of experiments on SI using robots. In their experiments, robots have two tasks: (1) augmenting SI by attending humans; (2) enhancing SI of a robotic receptionist by story-telling. An important role is

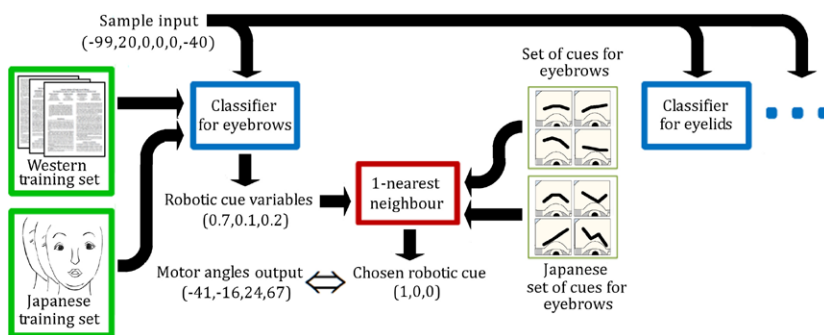
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<sup>12</sup><http://www.fipa.org>.

<sup>13</sup>The *stereotype* of robots defines the functional capabilities of a robot system.



**Fig. 2.2** Roboceptionist.  
©2013 IEEE. Reprinted, with  
permission, from Gockley  
et al. (2005)



**Fig. 2.3** Generator of culture-dependent facial expressions (reprinted from Trovato et al. (2012) with kind permission of Springer Science+Business Media)

played by models of “humanlike” behavior defined by appearance, emotions, personality of robots, and particular skills. In conclusion, the scholars discuss recommendations on the design of their robots that would address SI more precisely. For example, such robots will take initiative if somebody is looking at them and seeking contact.

In their approach, Trovato et al. (2012) discuss implementation of a culturally dependent social robot that communicates with humans by showing particular emotions and alters facial expressions correspondingly. The approach acknowledges differences in expressing emotions of the Japanese culture and the Western culture and claims the difficulty to substantiate the corresponding differences. Hence, to record emotional expressions for each culture, the approach collects drawings of emotions in comics relying on the Plutchick’s emotional wheel (Plutchik 2002) (Fig. 2.3).



Figure 2.3 shows the model of the culture-dependent robot that uses six statistical classifiers, one for each part of face, that regulate expression of emotions and calculate a vector of motor angles. For instance, the classifier for the eyebrows calculates motor angles for lowering eyebrows typical for anger or incomprehension. 75 subjects of different genders and nationality evaluated expressions of 12 emotions and evidenced in average good system performance in 68.8 % of experiments.

Summarizing revealed findings in SI and SS, social robotics distinguishes statistical processing, emotions, personality, space, and identity.

## 2.11 Computer Science

Computer science is actively engaged in comprehension of SI (Nakano et al. 2012; Rahman and Sahibuddin 2010; Yu et al. 2012). Such comprehension fosters research in HCI since it means various applications in the corresponding fields. For example, Social Intelligence (Nishida 2007) and Social Informatics<sup>14</sup> pay special attention to the issues of SI. Ishida (2006), Daisuke et al. (2005), Indraprastha (2011) share their experience on applications of SS. Gautam et al. (2009) urge a deeper understanding of cultural phenomena in social systems and claim that SI explains different problems of economics, business organizations, and computational systems.

Sun (2005a) describes certain aspects of cognition in the context of SS. He focuses on individual cognitive modeling and discusses means of interaction implemented in a MAS. Moreover, the scholar urges better understanding of individual cognition and sociocultural processes that can be achieved by SS.

The volume is divided into a part with an overview of cognitive architectures, a part with modeling and simulating cognitive processes, and a part that discusses SS and cognitive science. Consequently, research in cognitive, and social sciences address the following questions:

1. What are essential cognitive features that should be taken into consideration in computational simulation models?
2. What are the appropriate characteristics of cognitive architectures for modeling both individual cognitive agents and multiagent interaction?
3. How important is culture in shaping individual cognition and collective behavior?

To answer these questions, in Chap. 4, Sun (2005b) describes CLARION, an architecture that extends cognitive modeling to SS. This architecture considers psychological aspects of interaction and contains subsystems for

1. motivation for actions that arise, for instance, from biological needs of agents;
2. learning that considers adjustment of simulation system, for example, on the trial-and-error basis;

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<sup>14</sup>Social Informatics: <http://www.social-informatics.org>.

3. goal selection that includes the ability of the agents to dynamically modify their behavior according to external factors of the simulation environment.

The scholar claims that CLARION architecture allows realistic simulation of cognitive tasks due to the mentioned subsystems.

In Chap. 9, Gratch et al. (2005) address social emotions, for example, blame, and focus on their modeling to realistically represent human behavior. In SS, the scholars consider emotion models of cognitive behavior (also in nonverbal communication) and discuss face-to-face interaction in high-stress social settings. Claiming that emotions influence essential processes of cognition (decision making, planning, and beliefs), the scholars describe how coping strategies, such as denial or mental disengagement, can be influenced by emotions.

In Chap. 14, Castelfranchi (2005) addresses the crucial question of building believable SS concerning the interplay between individual and collectivistic aspects of cognitive agents such as social and cultural phenomena. Evidently, agents in a believable simulation MAS should have:

1. autonomy so that governing mechanisms of the MAS can “orchestrate” social structures;
2. “intentional stances” so that social behavior can be predicted and explained;
3. social motives such as selfishness or altruism to explain egocentric agents’ behavior;
4. social sources of beliefs and goals to substantiate them in a believable SS;
5. entities of identification in a group, for instance, “we” or “they”, to consider human tendency to identity;
6. social rules to organize SS according to a human society.

Thus, a believable SS relies on autonomous agents that are integrated in a social structure with its rules and norms and must therefore delegate some autonomy to organizational entities that regulate SS.

In Burns and Roszkowska (2005), the scholars discuss how social judgment can be considered in a MAS using the game theory. In their opinion, the essential entities influencing social judgments are situations with corresponding agents, their roles, relationships, and temporal issues.

The approach by Torii et al. (2004) addresses SI in the multilayer socio-environmental simulation by considering Q, a scenario description language, and CORMAS, an agent-based simulation framework that combines a physical environment and humans. The Q scenarios define sensing functions (cues) and acting functions (actions), whereas the mapping between cues/actions in Q scenarios and cues/actions in agent systems is specified by a Q adapter. A Q scenario can be attached to an existing MAS to control simulation.

Q is an extension of Scheme (Sussman and Steele Jr. 1975), a functional programming language, a Lisp dialect. CORMAS defines a framework that coordinates simulation of processes between individuals and groups and controls the resource access. For their tests, the scholars use the Fire-Fighter scenario, which defines a fireboss that starts SS and gives directions on rendezvous points of two fire fighters. Moreover, the fireboss gives directions to fire fighters on how to prevent fire and

calculates their routes. If the route has to be changed because fire is encountered on the route the fire fighters report it to the fireboss and wait for the revised route according to the present environmental information.

Vollmer et al. (2010) describe an approach to SI with robot systems aiming to learn cognitive skills from a tutor based on the learner's feedback. Specifically, the research answers the following questions: what kind of the feedback should a robot (in this case, the learner) produce to adjust tutor's presentation and at which time. Claiming that infants learn from their parents, the authors try to endow robot systems with social skills by providing the feedback. In their experiments, the authors use the feedback of infants of three age groups: prelexical (8–11 months), early lexical (12–23 months), and lexical (24–30 months). A child performs a task that was demonstrated by the parents and hence mimic them. As data, the scholars use the "Motionese corpus" that consists of video-recordings of 64 pairs of parents performing manipulative tasks.

The learning task is broken into three steps. In the first step, the sequential organization and features of SI are analyzed; in the second step, a systematic annotation with timestamps of interactional events is undertaken including information about gaze, speech, pointing and reaching gestures, smiles, and actions; in the third step, the proposed hypotheses of learning are verified statistically using collected information on interactional events and their timestamps. Concluding, the researchers claim promising results and give recommendations on implementing robot systems that learn SI by mimicking.

Berger et al. (2007) discuss e-Tourism and present means to implementing SI in a virtual community. They discuss problems of online portals and state that customers feel more secure when dealing with humans rather than with automatic portals. The scholars conclude that customers need a sophisticated 3D visualization of tourism products with a virtual lounge to exchange traveling experiences.

Kisilevich and Last (2010) explore SI in the context of online communities and argue that SI depends on language and culture. The scholars analyze profiles of SN members and identify factors that influence communication such as member's education and hobbies. To record member profiles, the scholars use a questionnaire containing 100 issues that reveal the psychological type of the members.

Skraba et al. (2009) describe an approach to building an SN on the basis of implicit information rather than on explicit "friendship" declarations. By tracking interactions between users, for example, logging interactions related to a particular topic, a matrix of interpersonal communications is composed. The approach introduces a framework for analysis of SI containing three layers: a collection layer that gathers information about SI of users, an analysis layer that scrutinizes gathered information, and an API layer that presents an interface to the constructed graph of SI. The gathering layer collects information about SI by collecting SMS and email interactions. The analysis layer identifies clusters of socially related users and hence calculates social proximity between users on the basis of context and habits. The API layer makes the constructed graph available based on the FOAF/RDF format<sup>15</sup>

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<sup>15</sup>The Friend of a Friend (FOAF) project <http://www.foaf-project.org/>.

to describe links in an SN. In conclusion, the scholars define their future goal in extending the set of SI types (not only SMS or email) so that their approach constructs more realistic SNs.

Danescu-Niculescu-Mizil et al. (2012) present an approach that analyzes influence of SI according to the role and power dimensions of interactants. Verifying the hypothesis that language coordination can be regulated through “a rich source of information about power difference in a group,” the scholars use a Wikipedia corpus with 240,436 conversational exchanges between editors<sup>16</sup> that discuss changes to pages and articles and a US Supreme Court corpus with oral arguments before the United States Supreme Court<sup>17</sup> containing 50,389 verbal exchanges for 204 cases.

The scholars formulate power differences as follows:

1. In the Wikipedia corpus, admins vs. non-admins: *admins* have more power than *non-admins*;
2. In the US Supreme Court corpus, Justices vs. Lawyers: the majority of nine Justices decide a case after comments and questions of lawyers.

To measure language coordination, the scholars use a statistical approach based on the Support Vector Machine (SVM) classifier (Witten and Frank (2005)) and extract different features, for example, bag-of-words<sup>18</sup> features.

Yassine and Hajj (2010) introduce a framework for composing online SN relying on statistical NL processing that analyzes emotions in comments of two users and reveals a social relationship between them. To compose an SN, the scholars employ a two-stage scheme.

In the first stage, the scholars use an unsupervised  $k$ -means classifier with  $k = 3$  to identify comments of three categories depending on their emotionality: the first category identifies if a comment is emotional or not (either negative or positive) using keyword spotting;<sup>19</sup> the second category identifies to what extent comments are emotional using the means of semantic affinity;<sup>20</sup> the third category identifies comments of potential friends using statistical NL processing. Since Internet comments have their own language, for example, contain intentional misspelling, the authors consider text preprocessing and improvement of identification of the third category using the real-world knowledge (Liu et al. 2003). The classification result of this stage is 85.6 % averaged over classes.

The second stage processes comments of the third category statistically and identifies social classes of interactant pairs: close friends or acquaintances. As data, the

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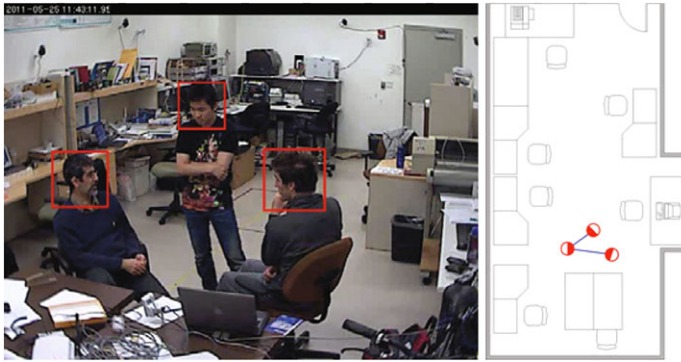
<sup>16</sup><http://en.wikipedia.org/wiki/Wikipedia:Administrators>.

<sup>17</sup><http://scdb.wustl.edu/>.

<sup>18</sup>The *bag-of-words* is a set of words in an analyzed text.

<sup>19</sup>*Keyword spotting* defines a technique that detects words from a particular set in a search text. For example, to identify if a text is emotional, keyword spotting searches for emotional words such as *happy* in the text.

<sup>20</sup>The *semantic affinity* shows the probability of particular sense of a word and is computed as, for example, the ratio of an emotional sense divided through the total number of word senses.



**Fig. 2.4** Multiple people tracking from Chen et al. (2011) (reprinted with kind permission of Springer Science+Business Media)

scholars use a corpus with 850 comments annotated by three labelers with interannotator agreement of 86.6 %. To classify the pairs, the approach extracts emotion words and stylistic features such as the number of capitalized letters. Using 10-fold cross-validation, the approach classifies pairs as close friends or just acquaintances using the SVM classifier and obtains accuracy of 87 %.

Paredes and Martins (2010) show an approach that analyzes users in virtual communities interacting with each other under consideration of psychological and sociological factors. The researchers state that such communities need regulation of SI. For this purpose, the scholars develop a virtual environment with 40 users that can be regulated by changing roles of users, defining rules and information flow. The performed experiments show interaction improvement, for example, better focus on goals of particular users.

Sun et al. (2011) investigate mimicry behavior in SI and its benefits. In scholars' opinion, mimicry enhances SI since computer systems endowed with the corresponding ability seem to be more social (emphatic) and intelligent. Consequently, they also consider integrating mimicry in social systems.

Chen et al. (2011) present a study of SI in a work environment. Claiming that the software development shifts to a human-centered paradigm the SI is part of, the scholars describe numerous benefits of their approach such as improvement of individual's well-being and productivity. The approach is evaluated using the system that maintains visual sensors and a map of working environment where a particular area of the office layout has its dedicated semantic task (*Working, Meeting, Printing, Door, and Special*). Moreover, the system maintains three layers: the *Sensor* layer that tracks locations of the users, the *Behavior* layer that maintains behavior models of the users, and the *Service* layer that generates particular recommendations on the basis of user behavior, for example, to take a break after a considerable period of working (Fig. 2.4).

Figure 2.4 shows the working environment with interactants (on the left) and the topology of the corresponding SN (on the right).

Peters (2011) focuses on design of ECAs engaged in SI and considers occurring emotions. The ECAs are endowed with human-like appearances and behaviors to interact with humans in a more natural manner. In scholar's opinion, SI describes beneficial means of analysis beyond the study of certain system components in isolation. Moreover, ECAs can behave believably and adapt to important interaction details such as change of facial expressions or gestures in that they alter accordingly their inner state and behavior.

Payr and Wallis (2011) focus on a socially situated agent and its behavior participating in SI in the physical world and present findings inspired by psychological and brain research. In researcher's opinion, SI is made up from emotions that participate in it, a social agent is "intrinsically emotional" or "relationships between such (social) agents are regulated by emotion." The scholars argue that SI involves not only verbal but also a nonverbal behavior. Using different examples, they elaborate on modeling social identities and describe ECAs with a model of social relationships.

Herrera et al. (2011) studies SI in group behaviors of different size (dyads vs. quads) and various cultures (American, Arab, and Mexican). The scholars claim that different sizes of groups can influence group behavior and acknowledge that communication in a group is influenced by emotions, demographics, and social relationships. To model communication, the scholars consider cultural model by Hofstede et al. (2005) and empirical data from Baxter (1970).

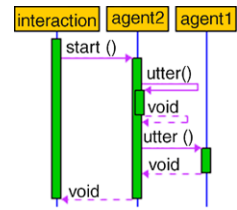
In their experiments, the researchers explore interaction between humans and ECAs. They collect a corpus with conversations and annotate turn-taking, gaze, and proxemics as behavior implications using the ANVIL tool (Kipp 2005). The results show that American quads pause more at turns than American dyads in turn-taking. Americans and Mexicans gaze at each other more in quads than in dyads, while Arabs gaze less in quads than in dyads. In proxemics, representatives of all cultures stand closer to each other in quads than in dyads. Since the results of this study differ from other results in literature, the authors propose further experimentation.

das Gracias Bruno Marietto et al. (2012) introduce a theoretical study of approaches for panic behavior of crowds in SS. Correspondingly, understanding this behavior can be beneficial to verify social theories and to get clear and detailed insights into panic theories. Moreover, corresponding findings can help to design safer and more efficient designs of public places such as theaters or stadiums.

The scholars discuss four theoretical approaches: the contagion theory approach that claims that a person loses his/her personality in a crowd and behaves according to the collective behavior, the interactionalism and emergent norm theory approach that relates individual behavior to the current situation, the structuralist theory approach that explores the influence of social structure on individual behavior, and the constructivist theory approach that considers influence of social context on social phenomena, for example, influence of educational context.

Further, the article studies the use of computer simulations in panic behavior and distinguishes its parameters such as modeling type, reactive or cognitive agents, micro- and macro-level explicitation, and communication method. Simulation modeling type distinguishes analytical/mathematical models vs. complex systems in SS.

**Fig. 2.5** A UML sequence diagram for social interaction



Reactive agents primarily response to stimuli from their environment whereas cognitive agents act according to cognitive aspects as the basis for their actions. The micro-level explicitation defines micro-components of simulation such as individual agents and their actions, whereas the macro-level explicitation considers general simulation components, for instance, societies. The communication method considers the way of interaction, for example, the direct message exchange that connects particular agents directly with each other or indirectly through a facilitator agent.

Approaches of Šišlák et al. (2009), Waters and Barrus (1997) use agent-based simulations as the basis for SS. Correspondingly, the comprehensible simulation allows interaction of agents in the 3D environment in the real time in a possible time-stepped mode. For this purpose, it maintains a 3D world and a wall clock defining relations to the real time.

Trajkovski and Collins (2009) address SI and SS in the context of psychology and sociology and discuss the corresponding challenges. The scholars claim that agents endowed with cognitive capabilities seem more compelling and focus on development of computer agents that experience emotions, empathy, or inference. SS can be developed as a MAS that considers cultural and temporal aspects. Moreover, SS can take into account communication and possible relationships between autonomous agents.

Zhang et al. (2009) focus on modeling cognitive agents in social systems considering urban dynamics. Accordingly, for better understanding issues of SS, researchers have to establish models that consider individual and social behaviors of interactants in simulation situations. The scholars discuss the definitions of agents and society and take the agent/society duality into special consideration: on the one side, an agent is an autonomous entity that has its own preferences and plans; on the other side, this agent is integrated in a social structure that defines groups, neighborhoods, or SNs and hence is not absolutely independent.

The approach addresses two goals. The first goal, reduction of interdependencies between agents by introducing a “meso-view” that groups agents of the same societal view. The second objective is improvement of decision making relying on psychological and sociological information.

Bersini (2012) discusses a methodology for developing SS systems that adopts Object-Oriented (OO) engineering practices using Unified Modeling Language (UML) (Fowler 2003). Correspondingly, an SS system that maintains agents participating in SI can utilize software-engineering approaches based on conventional UML diagrams, for instance, sequence diagrams (Fig. 2.5).

Figure 2.5 shows a UML diagram that defines SI between *agent1* and *agent2* that carry on a conversation by exchanging utterances.



Summarizing revealed findings in SI and SS, computer science distinguishes topology (SN), NL, relationships, emotions, context, MAS, personality, space, and statistical processing.

## 2.12 Summary of Findings

This chapter discussed related work in SI and SS and presented existing approaches from different sciences. Table 2.1 summarizes revealed findings and shows the corresponding keywords in parentheses.

Evidently, there are findings that can be considered as agent-specific. In contrast, there are also such findings that apply to the whole simulation and can be considered as simulation-wide.

This book discusses both agent-specific and simulation-wide findings (called hereafter modeling dimensions) in Sect. 3.5 after discussing own SI scenarios and proposes computational implementations of agent-specific dimensions in Sect. 6.4 and simulation-wide dimensions in Sect. 6.5.

## 2.13 Shortcomings of Previous Approaches

Table 2.1 shows findings from the perspective of different cognitive sciences and computer science. It presents a considerable amount of information that accompanies SI and SS. However, particular shortcomings of existing approaches are also evident:

1. There are no step-by-step guidelines on developing software systems that implement SS in different domains, although such software engineering guidelines are necessary for time-saving development of SS systems;
2. There is no comprehensive study of modeling dimensions that can be considered as computational dimensions necessary to build SS, although computational implementations of these dimensions are indispensable to implement computer systems (cf. trends in Friedlmeier 2007);
3. There is no generic approach to setting up experiments in the field of SS that allows prototyping simulation software for desired scenarios of (intercultural) SI;
4. There are no guidelines to prototyping SS systems of particular types, for example, dialog systems, although such guidelines (principle) are necessary to allow flexible development of SS systems.

## 2.14 Summary and Outlook

This chapter introduced numerous approaches to SI and SS. It presented corresponding agent-specific modeling dimensions that apply to certain agents and simulation-wide modeling dimensions that relate to the whole SS system.



**Table 2.1** Findings on social interaction and simulation

Disciplines	Findings
Sociology	(1) Topology (organic/virtual communities); (2) NL; (3) Attitudes and emotions; (4) Explicit specifications (surveys and interviews); (5) Emotions (opinions, emotional patterns); (6) Context;
Social Psychology	(1) Social relationships, emotions; (2) Context (situations, stereotypes); (3) Topology (groups); (4) Culture; (5) Verbal, nonverbal signs; (6) Explicit specifications (differential and generalization studies); (7) Alerts (constraints and methodological errors);
Sociolinguistics	(1) Culture, values, beliefs; (2) NL; (3) Context, relationships;
Anthropology	(1) Time; (2) Emotions; (3) Culture; (4) Demographics; (5) Context (situation, demographics); (6) NL (genre, code);
Learning	(1) Topology (groups, relationships); (2) Emotions; (3) Context (situations, a 3D image, labyrinth); (4) Culture; (5) Knowledge (simulation-wide);
Communication Studies	(1) Context (geopolitics, demographics, chronemics, proxemics, oculusics, kinesics, haptics, physical appearance, vocalics, olfactics); (2) Time (3) Culture; (4) NL; (5) Emotions (lightening, teasing);
Social Philosophy	(1) Identity (self) (2) Emotions (desires, interests, individual freedom, sufferings); (3) Personality; (4) Culture; (5) Dynamics; (6) Topology (groups, relationship);

**Table 2.1** (Continued)

Disciplines	Findings
Neurobiology	(1) Groups; (2) Context (brain signals); (3) Emotions (altruism, suspect, doubt, unfairness);
Medicine	(1) Context (agent-specific: demographics, race, age, physical health); (2) Emotions (interest reactivation, gain of nonsmoking, facial expressions, stress, loneliness and anxiety, self-confidence, optimism, respect, emotional isolation); (3) Repetitions (learning, training activity); (4) Groups (relationships, topology); (5) Context (simulation-wide: virtual environment, interactive playground, computer-mediated discussions); (6) Time (duration of SI), temporal recordings (simultaneous vs. consequential recordings);
Social Robotics	(1) NL (bag-of-words); (2) Emotions (acceptance, BDI); (3) Scenarios; (4) Simulation architecture (MAS); (5) Personality (character); (6) Input/output (LCD, appearance, scanning laser); (7) Context (agent-specific); (8) NL (roboceptionist, preprocessing); (9) Time (10) Statistical processing;
Computer Science	(1) Emotions (inner state); (2) Personality; (3) Culture; (4) Dynamic assignment of agents and behaviors; (5) Groups (age of children, demographics, education, hobbies, relationships); (6) Input/output (3D visualization, SMS, email); (7) Context; (8) NL (bag-of-words); (9) Topology (SN, micro- and macro-levels, communication method); (10) Explicit specifications (UML, social rules); (11) Reactive or cognitive agents; (11) Statistical processing;

Future work can reconsider existing approaches and present scenarios’ implications giving special consideration to the intercultural setting.

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