Navigating the world of emotions: Social Information processing in children with and without hearing loss

Tsou, Y.

Author: Tsou, Y.
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CHAPTER 1

General Introduction

“The boy sees that the girl is laughing, therefore he also feels happy.”

Can we safely assume that this conclusion is correct? It may be true in some situations, yet it can be rejected when the girl is laughing *at* the boy. Apparently, when one tries to understand one’s own or others’ emotions, the social context has to be taken into account.

When seeing this given situation, what would people do to infer the boy’s feeling? According to the Social Information Processing (SIP) model (Crick & Dodge, 1994; see Box 1), one of the first steps would be collecting relevant cues. What are the boy and the girl’s facial expressions? What are their body postures and actions? Then, the observer can integrate these cues to formulate an interpretation, and this interpretation would help decide how to respond to the situation.

However, which cues are relevant and how they should be integrated depend on one’s experiences in past social interactions, i.e., the “database” in the SIP model (Box 1). Children who have been deaf or hard of hearing (DHH) since early childhood therefore could establish and update their databases with experiences different from their typically-hearing (TH) peers. To what extent does being DHH affect children’s responses to social situations is the topic of the current thesis.

HEARING LOSS AND SOCIAL INFORMATION PROCESSING

Living in a dominantly hearing environment, DHH children miss out on a variety of information relevant for learning emotions and social rules when their attention is not directed to their source (Calderon & Greenberg, 2012). Even when they have focused the attention on the source, DHH children might still recruit only a fragment of information in situations with multiple talkers or background noises (Leibold et al., 2013). Moreover, the interactions between DHH children and their families have already been different since birth. Over 90% of the DHH children are born to hearing families (Mitchell & Karchmer, 2004), and parents with typical hearing often face difficulties attracting attention or communicating with a child with hearing loss (Harris & Chasin, 2005; Loots et al., 2005; Spencer et al., 1992; Traci & Koester, 2010; Vaccari & Marschark, 1997; Waxman & Spencer, 1997). This often results in a more directive and protective parenting style, with less turn-taking and shorter utterances in conversations, and less usage of mental-state language, compared to TH parents with TH children (Dirks et al., 2020; Morgan et al., 2014; Pinquart, 2013). Thus, DHH children may afford less opportunities to explore their environment, make mistakes and solve problems, or learn the causes and consequences of social situations (Calderon & Greenberg, 2012).

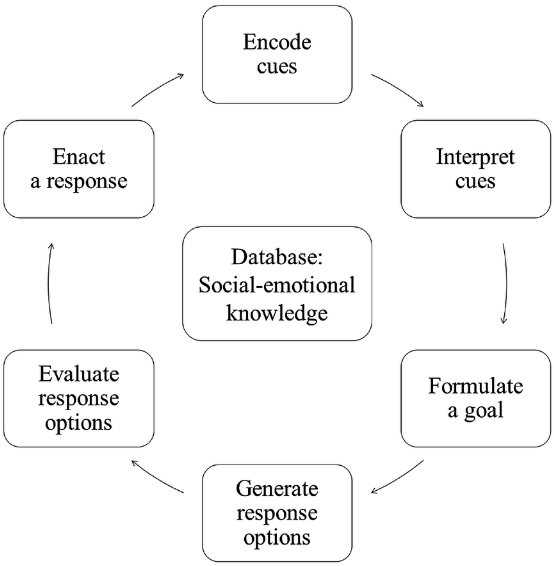

Figure 1. The Social Information Processing (SIP) model. For simplicity, the steps are illustrated sequentially. Yet, the steps could be in parallel and with numerous feedback loops (for more details, see Crick & Dodge, 1994; Dodge, 1991; Lemerise & Arsenio, 2000).

Although many DHH children are now with a hearing aid (HA) or a cochlear implant (CI) that significantly improves their hearing ability, they still experience the challenges mentioned above. Before these children receive a CI or a HA, they have limited auditory and language input. The fact that they do not gain sufficient access to the auditory social environment during the first year(s) of life has marked negative effect on their social-emotional knowledge and functioning (Mancini et al., 2016; Sundqvist et al., 2014), and psychological adjustment (Theunissen et al., 2014). After these children receive a HA or a CI, the auditory devices do not restore hearing to the full extent. The limitations of HAs and CIs cause difficulties for the users to hear the subtle differences in speech that are perceptible to TH listeners, such as different lexical tones, intonations, and emotional prosodies, or when there are background noises or multiple speakers (Leibold et al., 2013; Loizou & Poroy, 2001; See et al., 2013; Zeng, 2002). Parents and other family members can easily overestimate the hearing ability of a child with a CI or a HA, leaving their difficulties with learning social-emotional knowledge unnoticed (Marschark et al., 2012; Weisel et al., 2007).

Given the atypical experiences with social interactions since early childhood, DHH children are likely to establish and update their database for SIP with inputs distinctive from their TH peers. This could in turn guide them towards aberrant SIP patterns. Considering the higher prevalence of maladaptive social behaviors observed in DHH children, as compared to TH children (Chao et al., 2015; Dammeyer, 2009; Fellinger et al., 2008; Hoffman et al., 2016; Netten et al., 2015; Van Eldik et al., 2004; for a review, see Bigler et al., 2019, Stevenson et al., 2015, and Theunissen et al., 2014), it is of rehabilitative importance to investigate how DHH children process emotional information and react to social situations.

BOX 1. The Social Information Processing (SIP) Model

The SIP model denotes six successive, interdependent steps for processing social information (Crick & Dodge, 1994). How the social information is processed in these steps explains individual differences in behavioral responses to social situations. This well-documented and influential approach has been further extended to integrate emotional processes (De Castro et al., 2005; Lemerise & Arsenio, 2000). The integrated model proposes that, in the first step, people encode emotional information by focusing their attention on relevant cues in the social situation. Second, people interpret the emotion according to the cues encoded. In the next steps, people formulate the goal that they want to achieve in the situation, generate options of responses to the situation, and assess these options to make a decision. Finally, people enact the most positively evaluated response (see Figure 1; also see Lemerise & Arsenio, 2000 for more details about the SIP model integrated with emotional processes).

At each step, people are guided by the "database" they develop that consists of memories, experiences, and knowledge about emotions and social rules. This database allows people to know which cues are relevant, how to integrate and interpret the cues, and what the more socially favorable way is to respond to the situation. Atypical social-emotional learning experiences thus could lead to characteristic SIP patterns and maladaptive responses to social situations. Supporting the theory, empirical research on autistic children and children with intellectual disability showed that these children focused more on negative emotional information during the encoding stage and evaluated assertive response options less positively than their typically developing peers (Embregts & Van Nieuwenhuijzen, 2009). Likewise, children with conduct problems gave more hostile interpretations to non-hostile cues and generated more aggressive responses (De Castro et al., 2005; Horsley et al., 2010).

THIS THESIS

Aims

In the current thesis, the overall aim was to examine how DHH children respond to emotions in a social context. This aim was achieved by investigating three emotional processes, i.e., emotion understanding, empathic responding, and emotion expression/production, in the framework of the SIP theory.

Specifically, we first focused on the initial two steps of the SIP model, i.e., encoding and interpretation of emotional cues, to investigate the underlying patterns when DHH and TH children understand emotional information in others' facial expressions and in social situations.

Second, we examined the three emotional processes involved in the responses to emotions, and to what extent these emotional processes are related to psychosocial functioning in DHH and TH children.

Understanding Emotions in Faces and in Social Situations by DHH children

Human facial expressions are important cues in daily life. Yet, correct identification of facial emotional expressions is not enough for a child to interact with the social environment. They still need to be able to extract such information from a social context where an overwhelming amount of information is present, and interpret the emotions according to the social context in order to properly evaluate the situation they are in (Crick & Dodge, 1994; Lemerise & Arsenio, 2000).

The advanced eye-tracking and pupillometry technologies developed in recent years are useful tools for examining the encoding stage of emotion understanding because it measures where people are actually looking at and how they react physiologically (see Box 2). While to the best of our knowledge no studies have examined DHH children's physiological responses to emotional stimuli, a small number of studies showed that DHH individuals' experiences with hearing loss may lead to a different gaze pattern when understanding emotions in faces. Letourneau and Mitchell (2011) reported that American TH adults focused on the eye region when looking at emotional faces, while DHH adults distributed their gazes evenly on eyes and mouth, thus exhibiting longer mouth-looking time than TH adults. Watanabe and colleagues (2011) found a focus on the nose region in Japanese TH adults, whereas DHH adults looked longer at the eyes than the nose. Yet, contrary to the previous two studies on adults, Wang and colleagues (2017) found that DHH and TH children (aged 3 to 7 years) did not differ in gaze patterns on positive and neutral facial expressions, except for the condition with verbal cues. When facial expressions were accompanied by verbal cues, DHH children looked shorter at the upper half of the face than TH children. To the best of our knowledge, this study is also the only one that investigated gaze patterns to emotional faces in DHH children. These findings seem to indicate a tendency in TH individuals to look at a core feature when recognizing emotions in faces (i.e., the eyes or the nose, possibly related to the cultural background). The patterns in DHH individuals was less clear (see Box 3 for an introduction on visual attention in DHH individuals).

As to the interpretation of emotional faces, some researchers hypothesized that DHH children may be more sensitive to facial expressions (Ludlow et al., 2010) because neuroimaging studies showed a reorganization of the functional links between cortical regions specialized for visual and auditory processing in DHH individuals (Rouger et al., 2012; Stropahl et al., 2015). However, this hypothesis is not fully supported by previous studies. When preschool DHH children were asked to sort facial emotions or label faces with emotions, they were less accurate than their TH peers (Wang et al., 2011, 2016; Wiefferink et al., 2013). Yet, in school-aged children, emotion-matching skills were comparable between DHH and TH children (Hosie et al., 1998; Ziv et al., 2013). This may indicate that school-aged DHH children would catch up with their TH peers, at least in terms of matching the emotional faces

To the best of our knowledge, there is only one study available examining DHH individuals' encoding and interpretation of emotional cues in dynamic social situations (Torres et al., 2016). This study also applied the SIP model, and found that DHH participants encoded less relevant cues and made more misinterpretations than TH participants. Other studies focused on the stage of interpretation and used static stimuli, such as drawings or photos. In these studies, DHH children were also found to more often misinterpret the emotions triggered in social situations than their TH peers. While most TH children are able to attribute basic emotions to a social situation when they are 4 years old (Rieffe et al., 2005), DHH children aged 2.5 to 8 years show lower performance than age-matched TH peers (Gray et al., 2007; Wiefferink et al., 2013). One study pointed out that 5- to 7-year-old DHH children who used spoken language as primary communication mode performed similarly as their TH peers, whereas those used sign language were less accurate in

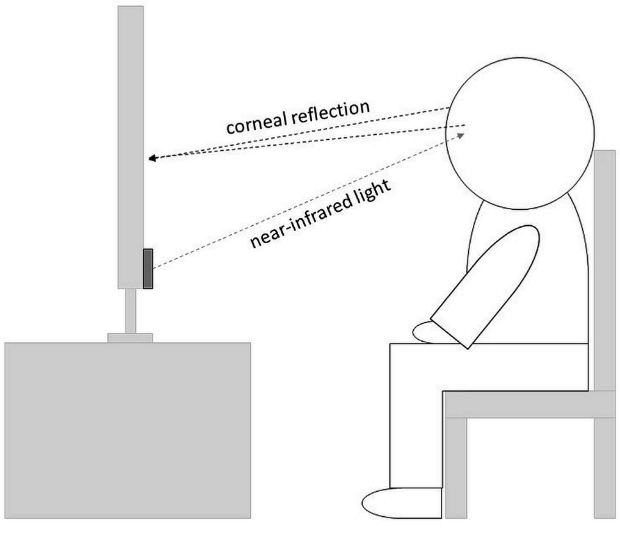

Figure 2. Lab setting for eye-tracking experiments in the current thesis (Chapter **2** and **3**). Participant sat 65 cm in front of a computer screen where an eye tracker was mounted. An experimenter sat next to the participant and controlled the experiments.

understanding emotions in a situational context, which was most likely due to limited social access in their educational setting where the staff were not all proficient in sign language (Ziv et al., 2013).

BOX 2. How Eye Tracking Works

Eye tracking is a sensor technology that measures eye movements, which allows a computer to know where an individual is looking, for how long the individual is looking at a particular location, and in what sequence the individual look at different spots in the visual field. Moreover, it provides pupillometry, a measure of the size of the pupils, which can be used as an indication of cognitive load or physiological arousal (Bradley et al., 2008).

An eye tracker consists of projectors, cameras, and advanced algorithms. The projectors emit invisible near-infrared light onto the eyes. High-definition cameras then record the direction of the light reflected off the cornea of the eyes. This corneal reflection techniques enables the position of the eyes, the gaze points, and the diameters of pupils to be calculated by a series of machine learning, image processing, and mathematical algorithms. Depending on the sampling rate of the eye tracker, the eye gazes and pupil diameter are captured multiple times a second (Tobii Pro, n.d.).

There are different types of eye trackers, such that are screen-based (mounted below computer screens) or wearable (as glasses or headset). Eye tracking allows eye movement to be measured in an unobtrusive manner and provides objective and quantifiable data.

Empathic Responses in the Social Context by DHH children

Empathy is a multifaceted capacity that enables people to feel others' emotions, and to affectively and appropriately respond to those emotions (Hoffman, 1990; Rieffe et al., 2010). According to the SIP model that integrates emotional processes (Lemerise & Arsenio, 2000), empathy allows people to shift their attention to others' emotional displays during the encoding stage, and empathic actions such as providing comfort or help are evaluated in the stage where different response options are assessed. Empathy is therefore an essential capacity for daily social participation as it guides our navigation of the social environment and stimulates prosocial responses (De Waal, 2010).

To date, little is known about DHH children's empathic skills. One study using teacher reports showed that the overall empathy levels in DHH children (aged 4 to 12 years) were lower than in their TH peers (Peterson, 2016). In studies that investigated separate empathic skills, the results were mixed. DHH and TH children did not differ in levels of affective empathy (Dirks et al., 2017; Netten, Rieffe, Theunissen, Soede, Dirks, Briaire, et al., 2015). Yet, parents of DHH children and DHH adolescents themselves reported fewer prosocial actions (Dirks et al., 2017; Netten, Rieffe, Theunissen, Soede, Dirks, Briaire, et al., 2015),

BOX 3. Visual Attention in DHH Individuals

There is a widely held myth that hearing loss would lead to enhanced visual ability. Empirical evidence shows that changes in the visual sensory domain following congenital hearing loss are actually rather specific. To date, the only behavioral difference between DHH and TH individuals that is replicable across studies is in the spatial distribution of visual attention. DHH individuals are faster and more accurate to detect an object or a motion in the peripheral visual field than TH individuals (e.g., Armstrong et al., 2002; Bavelier et al., 2000; Bosworth & Dobkins, 2002; Lore & Song, 1991; Neville et al., 1983; Neville & Lawson, 1987; Parasnis & Samar, 1985; Proksch & Bavelier, 2002). Likewise, DHH individuals are also more easily distracted by an irrelevant distractor in the periphery when they are asked to focus on a central target. By contrast, TH individuals find distractors presented centrally more distracting than peripheral distractors (Proksch & Bavelier, 2002).

The findings indicate that DHH individuals direct greater visual attention to the periphery, while TH individuals primarily attend to the center of the visual field. Possibly, congenital hearing loss leads to a preferred allocation of visual attention over the whole visual field to obtain more information, as a compensatory mechanism for the lack of auditory input (Dye et al., 2008; Letourneau & Mitchell, 2011; Proksch & Bavelier, 2002). Imagine that you are crossing the street without any auditory input from the environment, distributing visual attention to the peripheral locations to check the approaching cars appears to be a smart strategy for keeping yourself safe.

Importantly, such a change in visual spatial attention is chiefly driven by congenital hearing loss, rather than the use of sign language. When DHH signers and TH signers (i.e., TH individuals born to Deaf families) are compared, only the DHH signers exhibit greater attention to the peripheral visual field (Bavelier et al., 2001; Fine et al., 2005; Neville & Lawson, 1987b; Proksch & Bavelier, 2002). For a review on this topic, see Bavelier and colleagues (2006) and Dye and colleagues (2008).

whereas during an observational task DHH participants more often directed their attention to the person experiencing an emotion than TH participants (Ketelaar et al., 2013; Netten, Rieffe, Theunissen, Soede, Dirks, Briaire, et al., 2015).

Expressions of Own Emotions in the Social Context by DHH children

Emotion expressions are often part of people's enactment of responses to social situations. Expressing emotions helps people send specific information to their interaction partner(s) in regard to what is important to them and the goal they want to achieve in a social situation (Lemerise & Arsenio, 2000; Levenson, 1999). When a person reacts to a social situation with anger, he/she signals to the other(s) that there is a problem in the situation to be dealt with, or their relationship might be negatively affected. However, emotion expressions have to be guided by social rules, i.e., the display rules. Expressions of emotions, whether negative or positive, that are considered too frequent, intense, or prolonged by interaction partners could be harmful to social relationships (Liew et al., 2004; Rothbart et al., 2001; Sallquist et al., 2009; Wiefferink et al., 2012).

According to a small body of literature, DHH children (aged 1.5-5 years) were rated by their parents to express more frequent and more intense negative emotions than TH children, while the expression of positive emotions did not differ between DHH and TH children (Wiefferink et al., 2012). In emotion-provoking situations, DHH children's negative emotion expression remained intense after using a coping strategy (e.g., problem solving or avoidance) as compared to TH children (aged 9.5-13 years; Rieffe, 2012). Also, DHH children explained the causes of their anger less constructively than their TH peers, who expressed anger to communicate the discomfort the interaction partner caused (Rieffe & Meerum Terwogt, 2006). DHH children may express emotions in a less strategic manner to maintain or strengthen their relationships with others (Rieffe & Meerum Terwogt, 2006; Wiefferink et al., 2012).

Association between Responses to Emotions and Psychosocial Functioning

Being DHH during childhood is often reported to affect children's social functioning, leading to peer problems and psychopathological symptoms (Chao et al., 2015; Dammeyer, 2009; Fellinger et al., 2008; Hoffman et al., 2016; Netten, Rieffe, Theunissen, Soede, Dirks, Korver, et al., 2015; Van Eldik et al., 2004). A recent longitudinal study reported that children with a CI showed consistent lower levels of social competence, including lower adaptability and social interaction skills, than their TH peers four to eight years after implantation (chronological age 5 to 14 years; Hoffman et al., 2016). Also, the prevalence rates of internalizing and externalizing behaviors in DHH children are 4 to 14 percentage points higher than the rates in TH children (Fellinger et al., 2008; Stevenson et al., 2015; Van Eldik et al., 2004). Notably, the difficulties are not necessarily related to DHH children's auditory performance. Factors such as degree of hearing loss, age at amplification, unilateral/bilateral amplification, and receptive vocabulary were often found unrelated to social functioning in preschool and school-aged children (Dammeyer, 2009; Fellinger et al., 2008; Laugen et al., 2016; Netten, Rieffe, Theunissen, Soede, Dirks, Korver, et al., 2015; Stevenson et al., 2011).

Based on the SIP model, social behaviors are closely relate to how people respond to emotions. This is indeed what has been observed in typical development. For example, adaptive empathic responses to other people's emotions are consistently linked to better peer relationships (Eisenberg et al., 2010; Zhou et al., 2002) and fewer behavioral difficulties, such as internalizing behaviors like depression and anxiety (e.g., Smith, 2015; Tully & Donohue, 2017), and externalizing behaviors like aggression and conduct problems (e.g., Mayberry & Espelage, 2007; Pursell et al., 2008). When children are able to properly express their emotions towards others, share others' emotions, and know how to provide help or comfort, they can more skillfully engage in social interactions, thus establishing better social relationships (such as better-quality friendship; Denham et al., 1990; Zhou et al., 2002) and tending to do less harm to other people (Lovett & Sheffield, 2007; Rieffe & Meerum Terwogt, 2006).

Yet, to what extent are these findings applicable to children who are DHH? To our knowledge, only two studies have examined the relation between responses to emotions and social functioning in DHH children. Ketelaar and colleagues (2013) reported that higher levels of overall empathy was related to higher levels of social competence in DHH and TH children alike (aged 1-6 years). Yet, a positive correlation between emotion understanding and social competence was observed only in DHH children, but not in TH children, indicating the importance of understanding others' emotions in DHH children's social life. Wiefferink and colleagues (2012) showed that excessive expression of negative emotions was related to more externalizing behaviors in both DHH and TH children (aged 1-6 years). However, while TH children who expressed more positive emotions were regarded as more socially competent by their parents, such a relation was not found in DHH children. This might reflect that TH children expressed positive emotions more strategically than DHH children to maintain or strengthen their relationships with others (Rieffe & Meerum Terwogt, 2006; Wiefferink et al., 2012). Though limited in number, these studies show the possibility that DHH children respond to emotions differently, thus further hindering their social participation.

DHH CHILDREN IN TAIWAN AND IN THE NETHERLANDS

The majority of the aforementioned studies were done on children from the Western societies. Given that different language systems and cultures could affect how emotions are processed (e.g., Liu et al., 2015; Masuda et al., 2008; Ogarkova et al., 2009; Tanaka et al., 2010), studies done in the Western world may not be fully applicable to the other parts of the world. A small body of literature has shown that Western and East Asian people use different gaze patterns for encoding emotional faces: Eastern Asian viewers looked at the eye region for a longer time than Western viewers (Jack et al., 2009, 2012). Westerners and East Asians also differed in the interpretation of emotion category. For example, when interpreting angry faces posed by Japanese actors, Japanese subjects attributed more disgust, while American subjects attributed more sadness (Dailey et al., 2010). Moreover, East Asian children and adolescents were found to experience higher levels of personal emotional arousal than Western counterparts when witnessing other people's emotional displays (Cassels et al., 2010; Trommsdorff, 1995). To understand the generalizability of the current knowledge on emotional development, more studies on the non-Western samples are absolutely needed.

The current thesis includes DHH and TH children from Taiwan and from the Netherlands for different studies, aiming to increase the external validity of existing knowledge on DHH children's psychosocial development. Below information is provided in regard to culture, language, and support offered to DHH children in Taiwan and in the Netherlands.

Culture and Language

According to Hofstede's individualism-collectivism dimension, Taiwan is more collectivistic, while the Netherlands is more individualistic (Hofstede, 1984; Hofstede & Bond, 1984). Collectivistic-oriented cultures focus on the needs and goals of an individual's social group. The "I" is part of the "we," and people are encouraged to live up to the expectations and standards of the social group (Markus & Kitayama, 2014; Singelis, 1994; Wong & Tsai, 2007). Individualistic-oriented cultures focus on the needs and goals of the individuals themselves (Markus & Kitayama, 2014; Singelis, 1994), and thus promote self-responsibility, autonomy, and uniqueness of each individual (Oyserman et al., 2002; Realo et al., 2002).

Taiwanese Mandarin is the most widely used language in Taiwan. It is a variety of Mandarin Chinese and a tonal language. Different tones, i.e., pitches, distinguish the lexical meaning of a syllable. For example, *ma* with a high level tone means "mother," whereas *ma* with a falling tone means "scold." Taiwan also has its separate sign language, the Taiwanese Sign Language, which was developed from the Japanese Sign Language. Dutch is the language spoken by the majority of the people in the Netherlands. It is a West Germanic, non-tonal language. There is also a separate Dutch Sign Language in the Netherlands: Nederlandse Gebarentaal (NGT).

Prevalence of Hearing Loss and National Newborn Hearing Screening

Taiwan has 23.5 million inhabitants, of which around 120,000 have a disability related to hearing. Annually, about 200,000 babies are born (National Statistics Taiwan, n.d.). Approximately 700 of these newborns per annum are with a hearing loss (0.37%; Chen et al., 2015). As to the Netherlands, there are 17.1 million inhabitants. About 18,000 babies are born per annum (Statistics Netherlands, 2019), and among them about 300 newborns are with a hearing loss (0.17%; Van der Ploeg et al., 2015).

The national newborn hearing screening program started from year 2012 in Taiwan, and from year 2006 in the Netherlands. This program allows the hearing of newborns to be checked within 24 to 60 hours (Taiwan) or 4 to 7 days (the Netherlands) after birth, enabling early identification and treatment of hearing loss. As a result, in recent years more children are able to receive intervention at a younger age. Before the national newborn hearing screening program was launched, hearing loss in children was usually diagnosed after their first birthday. Therefore, the earlier start of the program allows the majority of DHH children in the Netherlands to receive a CI before the age of two years, while many DHH children in Taiwan receive implantation at a relatively older age (specific data unknown).

Intervention and Rehabilitation

When infants in Taiwan and in the Netherlands do not pass the newborn hearing screening after two rounds of tests, they are referred to a hospital or an audiological center for diagnosis. A team of medical doctors, audiologists, speech therapists, psychologists, and social workers does a series of examinations and provides support. After children are diagnosed with a hearing loss, they are introduced to suitable treatments, such as a HA trial or pre-CI tests.

In Taiwan, the costs of HAs are partially subsidized by the government when the degree of hearing loss is above 55 dB HL. All children under 18 years old who have bilateral severe-to-profound hearing loss and cannot benefit from HAs (e.g., hearing threshold surpasses 110 dB HL or the HA makes no improvement after three months) are eligible to receive a CI with the expenses covered by the national health insurance. Bilateral cochlear implantation is less common, most likely because only the first implant can be insured. Some hospitals initiate financial support projects for the second implant for children. In the Netherlands, the costs of HAs can be insured when the degree of hearing loss is above 35 dB HL. For children under 18 years old who are assessed by the CI team and deemed eligible for CIs, the first and the second CI can both be fully reimbursed by the insurer.

As to the rehabilitation in Taiwan, several foundations offer comprehensive aural-verbal rehabilitation programs for DHH children. These rehabilitation programs aim to help children listen and hear so as to communicate through spoken language. The most common programs involve a DHH child, a parent, and a teacher. The teacher stimulates children's hearing and verbal responses with a variety of activities and demonstrates to the parent what they can do at home. Other programs also include activities such as storytelling, music, and art that involve a group of DHH children.

In the Netherlands, sign-supported Dutch is encouraged in family interactions and used in rehabilitation programs from the start of intervention. A family-centered approach is adopted in rehabilitation programs. Such programs often include home visits by a family counselor, courses for parents and family members, and group treatments that involve a group of DHH children, a speech therapist, and two pedagogical counselors (one of them is also DHH). Regular sessions are provided to parents to watch the group treatments so they can learn the signs associated with a particular theme.

Education

Under the *Special Education Act*, children in Taiwan are placed in mainstream schools whenever possible. To address the needs of children with a disability, mainstream schools have three options to provide support: an external teacher for periodical extra guidance, a "resource room" in the school for regular extra guidance, and a special education class for placing students with special needs together. More than 70% of the DHH children go to regular classes without extra guidance, and about 15% receive one of the three extra support options (Special Education Transmit Net Taiwan, n.d.). Children who are not suitable for mainstream schools are placed in special education schools. These children take up about 12% among all preschool DHH children, and 6% among all school-aged DHH children.

In the Netherlands, the placement of DHH children is in accordance to the *Dutch Appropriate Education Act* of 2014. Schools have a "duty of care" to make adjustments to ensure that each child's needs can be addressed in mainstream education, or to offer alternatives (to another mainstream school or to a school providing special education). Beside basic support, schools need to adapt their teaching and, when needed, provide extra supervision and individual development plans. Children who are not possible to attend mainstream schools receive special education. About 0.5% of all primary school children go to special education schools for the DHH each year (Dienst Uitvoering Onderwijs, 2018; Onderwijs in Cijfers, 2019).

OUTLINE OF CHAPTERS

Applying the SIP model, this thesis examines the role of social-emotional learning, as a result of hearing status (DHH or TH), in children's responses to emotions in a social context. The first half of the thesis (Chapter 2 and 3) focusses on the encoding and interpretation patterns, i.e., the initial two steps of the SIP model, when children understand emotions in faces and in social situations. In the second half (Chapter 4 and 5), the focus is on the level and development of children's responses to emotions, as well as the association between these responses and psychosocial functioning.

In **Chapter 2**, we test how three- to ten-year-old DHH and TH children understand others' facial expressions of emotions. Using eye-tracking and pupillometry, we measure how these children scan the faces and their physiological arousal when they encode the emotions in faces, and later check how they interpret the emotions they observe. In **Chapter 3**, we further test how DHH and TH children understand emotions in dynamic, prototypical social situations. Again, we measure these children's eye movement to examine how the emotional cues in the dynamic social scenes are encoded, and ask for their interpretation of the emotion triggered by the social interaction. In **Chapter 4**, we examine how responses to emotions (emotion understanding, empathy, and emotion expression) are related to DHH and TH children's social competence and externalizing behaviors. In **Chapter 5**, we investigate the developmental trajectory of empathy in preschool DHH and TH children, and its association with early symptoms of psychopathology, using a longitudinal four-wave design. Finally, in **Chapter 6**, we summarize key findings, discuss implications for interventions, and suggest directions for future research.

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