Summary

Social touch is key for our emotional and physical well being throughout life and has strong affective qualities. When we receive less social touch than we desire, we can suffer from touch hunger, i.e. a lack of touch. A lack of touch can cause anxiety, depression and a reduction of overall wellbeing. Older adults are especially susceptible to touch hunger. Social touch can be mediated by technology in an effort to mitigate touch hunger. Wearable technology is a logical choice for the presentation of haptic stimuli, since a wearable is inherently close to the body. Active textile, a novel actuator type that could present soft pressure stimuli, is rapidly moving closer and can be fully integrated in a garment to create a haptic wearable, that could be used to mediate social touch. With such a wearable we could effectively mediate social touch between generations. A lot of the social touch we experience in daily life, like a hug or a comforting squeeze on the arm, is pressure based. In order to move towards inter-generational haptic interaction fundamental questions about the perception and experience of pressure touch need to be answered. This dissertation addresses six relevant knowledge gaps on the perception and experience of pressure touch.

(1) On the perception threshold of pressure. To present a perceivable haptic stimulus we need to know the perception threshold for pressure stimuli on a body location relevant for social touch. The perception thresholds for pressure on the arm found in this dissertation are 0.2 N or lower for a younger adults.

(2) On the effect of surface area on the perception threshold of pressure. We found that larger stimulation surfaces require less pressure to reach the perception threshold. Namely, 0.15 N per cm^2 for the stimulus with the smallest surface area (2.6 cm^2 for an arm circumference of 20 cm) and 0.01 N per cm^2 for the stimulus with the largest surface (41.7 cm^2 for an arm circumference of 20 cm) area both on the lower arm. This indicates a spatial summation effect for pressure stimuli.

(3) On the effect of actuation speed on the perception threshold of pressure. The actuation speed of a pressure stimulus may influence its perception threshold. This is relevant for the design of haptic actuators and haptic interaction. We found a significant effect of actuation speed on the perception threshold. Namely, a lower speed seems to increase the thresholds of normal force, pressure and indentation. This indicates that actuation speed and pressure perception threshold are correlated.

(4) On the effect of ageing on the perception threshold of pressure. When we grow older our senses deteriorate, including our tactile sense. Therefore, when we design for inter-generational haptic interaction, we have to consider that tactile sensitivity can differ. We investigated the perception threshold for pressure by a soft actuator in older adults and compared this with data for young adults. We found that the thresholds for older adults are higher than for younger adults in terms of force (average of 116 % higher for the lower arm and 120% for the upper arm), pressure (average of 111 % higher for the lower arm and 131% for the upper arm) and indentation (average of 15% higher for the lower arm and 8% for the upper arm). We also found that both groups show similar effects of spatial summation (i.e. lower force thresholds for larger surface area). This implies that the increased thresholds we found for older adults are likely caused by differences in the periphery, e.g. reduction in number, changes in morphology and receptive field size of mechanoreceptors, changes in skin morphology or any combination of the previous.

(5) On evoking haptic illusions with pressure. To design complex haptic interaction using pressure, we have to explore how we can use pressure stimuli to their full potential. Haptic illusions, such as apparent motion and apparent location, can be a part of this. If these illusions can be evoked with pressure, haptic patterns can increase in complexity without increasing the number of actuators or combining different types of actuators. We found that spatial integration of two simultaneously presented stimuli occurred for distances up to 61 mm. We found that apparent motion can be elicited with distinct pressure stimuli over a range of temporal parameters. These results clearly show spatio-temporal integration in the somatosensory system for pressure stimuli.

(6) On the affective qualities of pressure stimuli. This dissertation investigated whether there are inherent affective and sensory qualities associated with pressure stimuli, more in particular as a function of peak force, actuation speed, and surface area. Pressure stimuli parameters have inherent affective qualities. Especially peak force has a large effect on the experience of pressure touch.

The findings presented are not only relevant for the specific use of mediating inter-generational social touch, but also for touch mediation and simulation in a broad sense.