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# Discrimination of wetness levels with a robotic prosthetic device

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## Abstract

In the effort to restore the rich catalogue of sensations lost after hand amputation, few remain unaddressed. One among them is the ability to perceive whether an object is wet or dry. Here, we propose a sensory substitution approach taking advantage of the wetness illusion that a rapid drop in skin temperature can trigger to restore this peculiar capability. First, we verified the possibility of inducing an illusory sensation of moisture with a Peltier element on two body parts: the ventral upper arm and the abdomen. When applying cold dry stimuli on their skin a majority of participants (12/14) reported a sensation of moisture on the stimulation locations. Then, we used the MiniTouch, a portable thermal device, to mediate in real-time the thermal drop associated with the contact of a sensorized prosthetic finger with wet samples. The six healthy participants were able to discriminate the contact with 4 moisture levels (ranging from dry to soak wet) with an accuracy above the chance level (arm: 53.3%, abdomen: 62.5%, chance level with  $P < 0.01$ : 40%). Finally, to demonstrate the validity of our system in a more plausible setting, we mounted the MiniTouch on the prosthetic robotic hand of a male transradial amputee and allowed him to scan the samples autonomously. The subject could accurately distinguish the three levels of moisture (arm: 86.6%). Interestingly, when turning off the device the performance dropped (33.3%) proving that he relied mainly on thermal clues.

**Keywords:** wetness, sensory substitution, prosthetics

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