Perceived electrical shock and Bayesian inference with multisensory stimuli

An electrical-accident victim's recollection may be dramatically distorted by Bayesian inference in multisensory integration. Suddenly hearing the sound and seeing the bright flash of an electrical arc can cause a person to form the honest but false impression that they had experienced an electrical shock. Bayesian causal inference governs multisensory perceptual processing in general [1, 2]. If the sensory signals are largely consistent, the brain will infer a common cause for the signals and integrate them [1, 3-6].

Because an electric shock is often accompanied with certain visual, tactile, and auditory sensations, the prior expectation of a shock in presence of those sensations is high. Moreover, if the sensations are consistent with those of an electric shock and there is sufficient consistency in spatial and temporal attributes of the sensory signals to give rise to the inference of a common cause, there will be an illusory percept of an electric shock. Given that most people have no experience of past electric shocks, and therefore the "usual" electrical perception is not within their knowledge, it is easy for the brain to adopt those past reports from others and incorporate them into the reasoning.

We do research on electrical injury or multisensory perception (SL) and wish to present this concept to emergency physicians with 2 cases.

A 48-year old female was wiggling a vertical conduit out of the ground that had been the previous connection for her electric utility meter in Louisiana. These movements breached the deteriorating underground insulation for the 220 VAC 60 Hz feeder line to her house. The utility company had neglected to disconnect this source at the power pole transformer. Internal conductors shorted together and the victim heard a loud arcing noise and saw "fire" come out of the conduit (Fig. 1).

The victim was startled by the contact and later complained of various seemingly neurological symptoms. There was no ohmic path to ground since the subject was wearing insulating thick-soled athletic shoes on dry soil.

The peak current, before the primary power-line fuse blew, was calculated as 100–200 A which is in the range of arc welding which produces such bright light that goggles are required to prevent ocular damage. Typical sound intensity is 90 dBA from a welding arc. The light and sound levels reflecting up the conduit towards the subject would have been impressively high. The subject did not actually receive a perceptible current but probably had a Bayesian inference multisensory integration response [7].

A 26-year old Indiana welder was startled when the torch on his welder suffered a failure in the water cooling-system, melting the insulation on the current-carrying wire and producing a very noxious smoke (see Fig. 2). He described being shocked and burned by the exposed wire.

The emergency department records state:

> He was welding - at that time he was leaning against a pole when he felt a shock to his right arm. He noticed a scratch and then the smoke from his cable. He removed his mask and garment and ran to the other side of the building - turning off the welder and the electricity feeding the welder. He was "shook up" and had some tingling in his right arm but didn't think much of it.

Just 2 days later he presented at a hospital and described pains in his chest and right arm. He stated that his left arm was "grounded" by the pole but then also described a shock sensation in his left steel-toe tip.

The subject was wearing boots, pants, long-sleeved work shirt, sheepskin welding gloves and a welding helmet. There was no current path as the entire body — except for the back of his head — was insulated against low-voltage shocks. The available voltage was ~60 VDC. No clothing damage was documented by inspection or photography to establish either of the insulation breeches required for an electrical contact. We recreated the incident with the identical equipment and clothing and found there was no current passed.

In our opinion, the subject was startled by noxious smoke coming into his welding helmet as well as a sudden sensation of high-temperature on his forearm. Recognizing that he was working around an electrical source, he may have formed a Bayesian multi-sensory misperception of an electrical shock [8].

Descriptions of electrical shocks are fraught with subjectivity and misunderstanding. Bayesian inference in multi-sensory perception can lead to a subject sincerely believing they had suffered an electrical shock when there actually was no electrical shock received. Emergency physicians should be aware that recalled sensations — thought to be corroborating — may actually be confounding.

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Fig. 1. Subject grasping a utility power conduit.

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Fig. 2. Melted insulation on welding cable.