TamagoPhone: Augmented incubator to maintain vocal interaction between bird parents and egg during artificial incubation.

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It is common practice for zoos and bird conservationists to incubate bird eggs in artificial incubators to maximize hatching rates. In the wild or even in zoos within enclosures, eggs can be vulnerable to predators, diseases or temperature problems, and the use of artificial incubators during part or the entirety of the incubation time can greatly improve the chances of survival of the chicks and support preservation efforts for endangered species. However, some species exhibit important prenatal vocal interaction while within the egg. Indeed, parent birds often produce vocalisations directed to their eggs and in some species, chicks produce calls from within the egg a few days before hatching. Standard artificial incubation techniques deprive embryonic chicks of integral parent-offspring vocal communications during early development. Recent research has shed light on specific behavioral contexts associated with vocal pre-hatching events for specific species. Led by such research, there have been attempts of using curated static recordings during artificial incubation and hand-rearing to alleviate the lack of vocal interactions. However, our understanding of those vocal interactions is still in its infancy, and might never be understood well enough to synthesize meaningful replacement or select relevant recordings. Instead, we propose supplementing existing egg incubation techniques with a two-way, real-time audio system to allow parent birds and unhatched eggs to communicate with each other remotely in real-time during incubation. To achieve this, we designed a framework and approach called TamagoPhone. With this approach, the real egg removed from the nest is replaced by an augmented "dummy" egg, embedding a microphone and speaker, which is then cared for by the parent. The artificial incubator is also augmented with microphones and speakers, in addition to the traditional temperature, humidity, and motion control systems. Both sides, parent and egg, are connected by a two-way audio streaming platform, with the audio components inconspicuously integrated.

Previous research on responsiveness and vocalization in bird embryos supports our investigations. It is now well established that avian prenatal sensory experience affects development and has long-term consequences on postnatal behavior, which varies between altricial and precocial species. Species of birds who are able to feed themselves, are covered with down, have their eyes open, and leave the nest days following hatching, are classed as precocial. Birds with closed eyes, very little down, who are unable to leave the nest for some time are classified as altricial. Previous work has highlighted the development of auditory sensitivity of bird embryos prior to hatching.

In this work, we first review previous research on known functions of both parental and embryonic vocal signals, we then describe the TamagoPhone intervention and its potential application in various contexts including preservation, research, and farming. Finally, we propose a taxonomy of success criteria and evaluation metrics for each application context. We believe that such a system could be a way to use technology to increase vocal connectivity between the mother and her young while acknowledging our human limitations in understanding the possible meanings and functions of the vocal signals exchanged.