



Rethinking same-sex sexual behavior: From sensory error to social function

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Same-sex sexual behavior (SSB)—defined as sexual interactions between conspecifics of the same biological sex—has long fascinated academics and the broader public (1). Although the past few decades have witnessed a surge in theoretical support and experimental rigor devoted to understanding SSB, detailed observations of such behavior date back more than half a century (2). Historically, however, the scientific community has been deeply skeptical, often dismissing SSB as “misdirected” courtship (3). This perspective was vividly illustrated by Australian buprestid beetles attempting to copulate with discarded brown beer bottles, a classic case of sensory entrapment that came to epitomize early interpretations of SSB as misdirected courtship (4).

Today, the existence and widespread occurrence of SSB is no longer in question. It has been documented in over 1,500 animal species, spanning nearly every major lineage (5), including invertebrates such as echinoderms (6) and arthropods (7), as well as vertebrates ranging from birds (8) to mammals (9). SSB is also frequently observed in humans across diverse cultures and historical periods. As a result, the central challenge has shifted from documenting the phenomenon to explaining its evolutionary persistence. Against this backdrop, Green et al. (10), writing in PNAS, empirically test competing hypotheses about the function of SSB in multiple species of field crickets. They demonstrate that individuals engaging in SSB are not mistaking their partners' identity; instead, SSB is associated with reduced aggression, pointing to an adaptive social function that may help explain its evolutionary persistence.

The Darwinian Paradox

To appreciate the significance of this finding, it is important to recognize why SSB has long been framed as a Darwinian paradox. SSB entails not only the energetic costs associated with mate acquisition and copulation but also substantial opportunity costs, as individuals engaging in SSB may forgo reproductive encounters with the opposite sex. Under traditional models of selection centered on individual fitness maximization, such behavior appears difficult to reconcile. Consequently, much of the literature on SSB has sought to explain how it could originate and persist despite these apparent costs.

Population genetic models, however, have demonstrated that genes influencing SSB can persist under a surprisingly broad range of conditions (11), suggesting that individuals exhibiting both opposite-sex and same-sex sexual behaviors should be prevalent. More recently though, researchers have questioned a more fundamental assumption underlying the paradox itself: that SSB is necessarily a derived trait evolving from an ancestral state of exclusive different-sex sexual

behavior (DSB). Monk et al. (12) proposed instead that early sexually reproducing animals may have engaged in indiscriminate sexual behavior, with both SSB and DSB representing ancestral traits. While this hypothesis provides a compelling explanation for the widespread taxonomic distribution of SSB, it does not fully account for its persistence in contemporary species. In such systems, the question of function remains open.

Adaptive and Nonadaptive Explanations

To address this gap, researchers have proposed a range of adaptive hypotheses that invoke indirect fitness benefits. These include the idea that SSB provides younger or inexperienced individuals with opportunities to practice courtship or mounting, thereby enhancing future reproductive success, as shown in *Drosophila* (13). In social species, SSB has also been implicated in mediating social interactions: observations in bottlenose dolphins (14) and studies of dominance hierarchies in arthropods (15) suggest that SSB can function to manage or resolve social tension. Similarly, the “tension reduction” hypothesis posits that SSB acts as a social lubricant by mitigating intrasexual aggression—a function most famously described in bonobos (16). Among these, the tension reduction hypothesis is uniquely testable in systems with quantifiable aggression and courtship.

By contrast, nonadaptive explanations attribute SSB to constraints or errors rather than fitness benefits. These include sexual frustration following rejection by opposite-sex individuals (17) or skewed sex ratios that limit access to mates (18). The most widely invoked nonadaptive explanation, however, is the “mistaken identity” hypothesis (3). According to this view, the cost of occasionally misidentifying a potential mate is outweighed by the cost of failing to mate altogether (1). As a result, mistaken identity has often been treated as a convenient null hypothesis, invoked whenever an adaptive function for SSB cannot be readily demonstrated.

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Challenging the Null

Green et al. (10) directly challenge this reliance on mistaken identity as a default explanation. They argue that an absence of evidence for adaptive function should not be mistaken for evidence of nonfunction—a distinction that has influenced interpretations of SSB in vertebrates but has been largely overlooked in invertebrate systems. Crucially, the authors explicitly test a key assumption underlying the mistaken identity hypothesis: that SSB arises from failures of sex recognition by one or both interacting individuals.

“Against this backdrop, Green et al. (10), writing in PNAS, empirically test competing hypotheses about the function of SSB in multiple species of field crickets.”

Using a series of dyadic interactions between conspecific males, the authors demonstrate that individuals are capable of discriminating between sexes and yet still engage in SSB. Having established that SSB is not simply the product of sensory error, they then ask whether it serves an adaptive social function. A great strength of their work is that they specifically test the tension reduction hypothesis against the mistaken identity hypothesis using multiple species of field crickets as a model system. Crickets are particularly well suited to this approach for two reasons. First, sex discrimination is straightforward, as only males produce acoustic signals, a strongly sexually dimorphic trait. Second, courtship and aggression are communicated through distinct acoustic signals, allowing behavioral decisions to be quantified.

By combining temporal analyses of behavior with structural equation modelling, Green et al. (10) reveal a clear negative

association between courtship and aggression during male-male interactions. These findings support the interpretation that SSB reflects a deliberate behavioral strategy rather than a sensory mistake, consistent with its role as a mechanism for reducing intrasexual aggression.

Toward Broader Frameworks

Although limited taxonomic sampling currently precludes formal comparative analyses, the study lays important groundwork for understanding how SSB evolved within and beyond field crickets. Such analyses would be particularly informative for evaluating whether SSB and DSB are indeed ancestral traits across lineages. If so, the traditional framing of SSB as an evolutionary anomaly would need to be reconsidered, shifting attention toward understanding the ecological and social conditions under which SSB is absent rather than present (12). In mammals, however, ancestral reconstructions suggest that SSB has evolved multiple times independently (9), in line with predictions by Clive et al., highlighting substantial diversity in evolutionary trajectories (19).

Despite its sexual form, SSB is frequently co-opted for nonreproductive functions (1), including mitigating intrasexual conflict (16), reinforcing social bonds (14), and clarifying dominance relationships (15). This convergence of function across taxa with potentially distinct evolutionary histories suggests that the maintenance of SSB may be strongly context dependent. Future work should therefore build on mechanistic approaches such as those employed by Green et al. to develop conceptual frameworks capable of predicting when and why SSB emerges from the interplay of social environment, life history, and ecological context (20).

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