

Behavioral Responses of *Betta splendens* to Environmental Factors

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ABSTRACT

Environmental conditions play a crucial role in shaping the behavioral patterns and overall welfare of aquarium fish species. This study examined the effects of three specific environmental factors—tank size, colored lighting, and sound exposure—on the behavior of male *Betta splendens* (Siamese fighting fish). Experiments were conducted under controlled indoor conditions, and behavioral responses were assessed based on swimming activity, exploration, hiding, resting, and aggression. Results indicated that larger tanks promoted natural and active behavior, while restricted spaces increased signs of stress such as hiding and inactivity. Lighting color significantly influenced aggression and exploratory patterns, with red light inducing more territorial behavior and blue light eliciting calmness and curiosity. Exposure to natural underwater sounds supported active behavior, whereas artificial piano music caused increased hiding and resting. These findings underscore the importance of optimizing captive environments for *Betta splendens*, both for enhancing welfare and maintaining natural behavior in ornamental settings.

INTRODUCTION

Betta splendens, commonly known as Siamese fighting fish, is a widely kept freshwater ornamental species native to Southeast Asia, particularly Thailand, Cambodia, and Vietnam. Known for their vivid coloration, long flowing fins, and territorial aggression—especially in males—Betta fish have become a subject of interest in studies of environmental influence on fish behavior.

Behavioral responses in *Betta fish* are modulated by a variety of environmental stimuli such as tank size, lighting conditions, and sound exposure. These factors affect not only activity levels and territoriality but also stress-related behaviors including hiding, erratic swimming, and feeding suppression.

Understanding how specific environmental conditions influence the behavior of *Betta splendens* can provide valuable insights for improving aquarium management practices and animal welfare. This study explores the behavioral responses of male Betta fish to three controlled environmental variables: tank size, colored light exposure, and sound conditions.

Methodology

All experiments were conducted in a controlled indoor environment with stable water quality (pH ~7.0, temperature 28-30°C). A total of 9 male *Betta splendens* were used for each experimental condition, with all three experiments conducted in triplicate to ensure data reliability.

Tank Size Experiment: Fish were housed individually in three different tank volumes. Prior to observation, each fish was acclimated for 15 minutes, followed by a 10-minute behavioral assessment.

Light Experiment: Fish were exposed to three types of LED lighting—white (400 - 700 nm), red (625-750 nm), and blue (450 and 495 nm)—within a standard 9-gallon aquarium. Each lighting

condition lasted 10 minutes per trial, during which observation was recorded.

Sound Experiment: Behavioral responses were observed under three auditory conditions: natural underwater bubble sounds, soft piano music, and a no-sound control. These trials were conducted in a 1.5-gallon aquarium, with each session lasting 10 minutes, during which observation was recorded.

Behavioral metrics included swimming activity, exploratory behavior, hiding, resting, and signs of aggression, which subject to simple statistical analysis. All observations were recorded on video for detailed analysis.

Results

Behavioral data were compiled and visualized to compare responses across different conditions.

Fig 1 illustrates the behavioral responses of *Betta splendens* under different tank sizes. Fish placed in the large aquarium exhibited the highest levels of swimming and exploratory activity, highlighting the importance of space in encouraging natural behaviors. In contrast, those in the small aquarium and fishbowl spent more time hiding and resting, indicating increased stress and reduced comfort due to spatial confinement. These observations suggest that limited space can significantly restrict behavioral expression and contribute to elevated stress levels.

Fig 2 presents the impact of colored lighting on behavior. Fish under white light displayed a balanced pattern of activity with moderate aggression, indicating a neutral effect on their stress levels. Red light exposure, however, led to heightened aggression and frequent hiding, reflecting territorial stress possibly triggered by visual overstimulation. In contrast, blue light was associated with calm, exploratory behavior and minimal aggression, suggesting a soothing influence that supports a healthier behavioral profile in captive Betta fish.

Fig. 1: Behavioral Responses under Different Tank Sizes

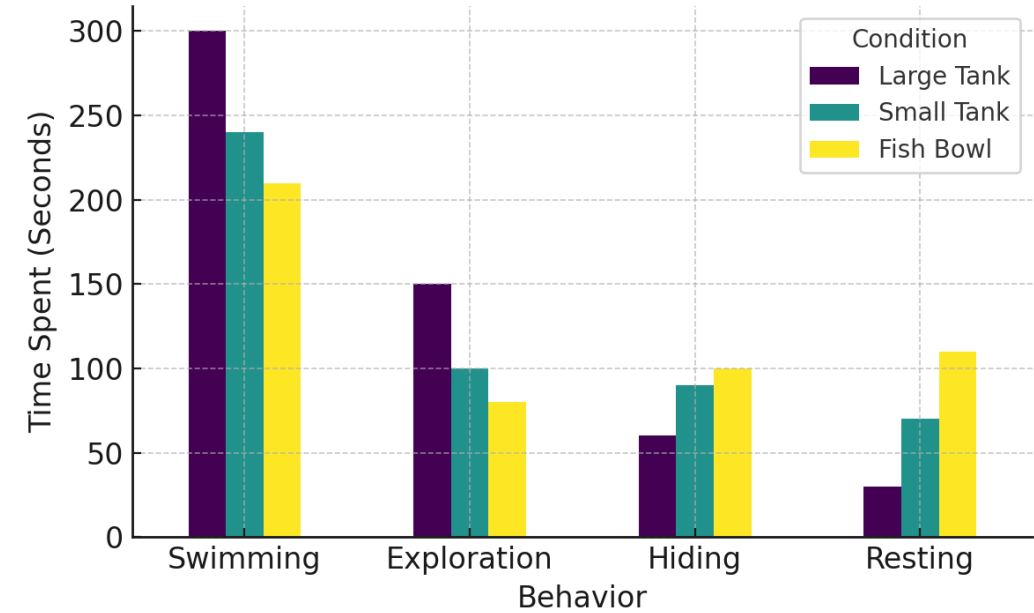


Fig 2. Behavioral Responses under Different Light Conditions

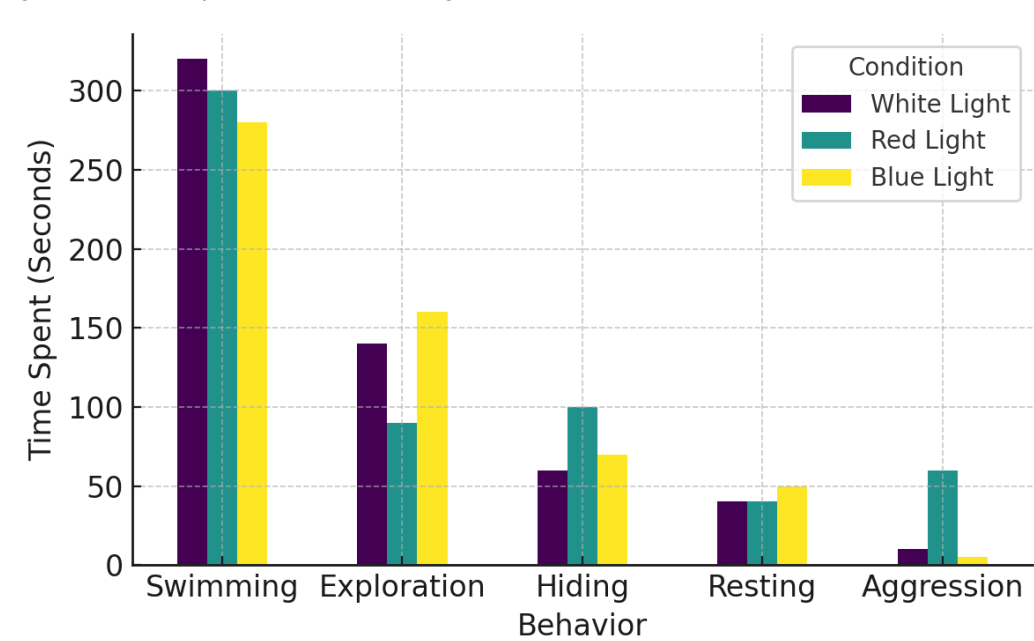
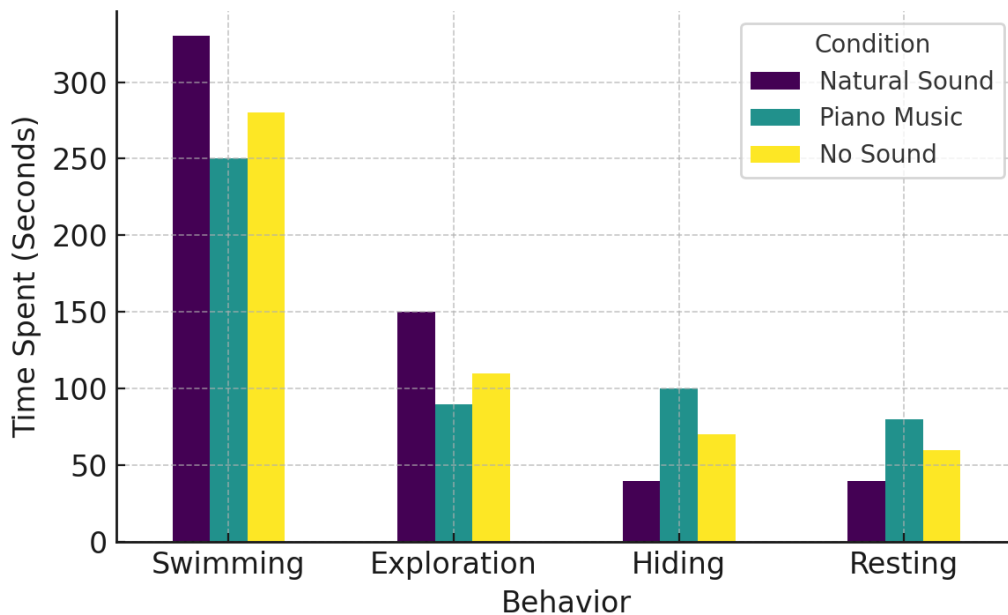


Fig 3 compares the effects of different auditory environments. Natural underwater sounds elicited the most active swimming and exploration, with very low indicators of stress, suggesting that such sounds replicate aspects of the fish's natural habitat. Exposure to piano music resulted in increased hiding and resting

Fig. 3. Behavioral Responses under Different Sound Conditions

behaviors, pointing to discomfort or sensory disturbance. The control condition with no sound showed intermediate responses, with lower stimulation than the natural sound condition but less avoidance behavior than observed with music.



DISCUSSION

Tank size had a direct impact on the behavioral expression of *Betta splendens*. Larger tanks allowed for natural movement and territorial exploration, while smaller environments constrained activity and promoted stress-induced behaviors such as hiding and resting.

Lighting conditions significantly influenced the behavior of *Betta splendens*. Exposure to red light was associated with heightened aggression and stress, likely due to visual overstimulation. This observation is consistent with the findings of Irawan & Afiati, who reported increased territorial responses in fish under colored lighting, especially higher wavelengths. In contrast, blue light appeared to have a soothing effect, encouraging exploratory behavior and indicating a more relaxed state. Inappropriate or excessive lighting can induce light-related stress in fish, which may manifest as behavioral changes, weakened immunity, and impaired reproductive function. Therefore, understanding and catering to the specific lighting requirements of each species is essential for maintaining a healthy and stress-free aquarium environment. Sound stimuli yielded distinct outcomes. Natural underwater sounds mimicked the fish's native environment, enhancing exploration and comfort. Piano music, an artificial acoustic input, led to more passive and avoidance behaviors—suggesting that not all auditory enrichment is beneficial.

CONCLUSION

This research emphasizes the need for careful consideration of environmental enrichment in Betta fish care. By demonstrating how tank size, lighting, and sound affect behavior, this study provides actionable recommendations for aquarists, pet stores, and researchers. Ensuring appropriate spatial environments, avoiding overstimulating light colors, and selecting natural

soundscapes can significantly improve the quality of life for *Betta splendens* in captivity.

REFERENCES

- Low, T. (2018). The Complete Guide. TFH Publications.
- Oldfield, R. G., & Murphy, E. K. (2024). Life in a fishbowl: Space and environmental enrichment affect behaviour of *Betta splendens*. *Animal welfare (South Mimms, England)*, 33, e1. <https://doi.org/10.1017/awf.2024.1>
- Evans, M. R., & Norris, K. (1996). The importance of carotenoids in signaling during aggressive interactions between male firemouth cichlids (*Cichlasoma meeki*). *Behavioral Ecology*.
- Kalueff, A. V., Stewart, A. M., & Kyzar, E. J. (2014). Neurophenotyping of zebrafish social behavior. *Journal of Neuroscience Methods*.
- Irawan, B., & Afiati, N. (2006). Aggressive behavior of male Siamese fighting fish (*Betta splendens*) in different colored environments. *Aquacultura Indonesiana*.
- Johnny (2023). The Aquarium Expert. Can Betta Fish Hear Music? Retrieved from <https://theaquariumexpert.com/can-betta-fish-hearmusic>
- Volpato, G. L., & Barreto, R. E. (2001). Environmental blue light prevents stress in the fish Nile tilapia. *Brazilian journal of medical and biological research = Revistabrasileira de pesquisas medicas e biologicas*, 34(8), 1041-1045. <https://doi.org/10.1590/s0100-879x2001000800011>