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The Bold and the Shy: Individual Differences in Rainbow Trout

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ABSTRACT

Boldness and shyness were investigated as 'personality' traits in hatchery-reared rainbow trout *Oncorhynchus mykiss*. Bold fish spent more time in an open area and were more active than shy fish and these behaviours could be used as indicators of boldness and shyness. These differences were related to learning ability in a simple conditioning task. Bold fish learned the task more quickly than shy fish.

There has been a decline in wild fish populations due to many factors including overfishing and this has encouraged the practice of population enhancement by release of hatchery-reared species. The ecological impacts of releasing captive reared fishes have come under increasing scrutiny from welfare and economic perspectives. Hatchery fishes are reared in a barren environment and upon release into the wild they face a myriad of behavioural and physiological challenges. The majority of released fishes suffer mortality (McNeil, 1991) due to a variety of factors including their inability to recognize, capture and handle live prey and also their inexperience and reduced vigilance makes them more vulnerable to predation (Olla et al., 1998). Therefore studies have addressed this problem by improving the survivorship skills of the released hatchery fishes by pre-release training (e.g. pre-release exposure to live prey; exposure to predators before release into the wild can also improve the chance of a fish surviving). These studies have shown that simple behavioural measures can enhance the survivorship skills of fishes and the social transmission of skills would enable the fish farmer to train a few individuals that could act as a model for the many upon release (Suboski & Templeton, 1989). Brown & Laland (2001) stressed the importance of pre-release training to enhance behavioural skills and suggested that these skills would be transmitted to other conspecific fish by social learning. Brown & Laland (2001), however, did not suggest how to choose the role models. Individual variability in behavioural responses has been demonstrated in fishes (Kieffer & Colgan, 1992) and hence it is important to determine what are the most important characteristics of the fishes to be selected as role models.

Learning ability or speed of acquiring a task in fishes has not been fully explored although it has been demonstrated that bluegill *Lepomis macrochirus* Rafinesque are faster learners than pumpkinseed *Lepomis gibbosus* (L.) (Kieffer & Colgan, 1992). Studies on other species have demonstrated that individuals can be bold (also termed sociable) or shy (also termed fearful or timid) and that this can influence an animal's reactivity to a variety of situations. This diversity of behavioural strategies adopted by individuals within species has been observed in a variety of animals including pumpkinseed (Wilson et al., 1993). In humans this phenomenon is known as the 'shy bold continuum' and is thought to be the fundamental axis of behavioural variation (Wilson et al., 1993, 1994). Individual variation in 'temperament' or 'personality' may affect how animals react to novel situations, avoid predators, invest in reproduction and behave in a variety of social contexts (Reale et al., 2000). The present study investigated whether rainbow trout *Oncorhynchus mykiss* (Walbaum) could be classified into bold and shy individuals based on their behavioural output. Since boldness and shyness affect the willingness to take risks, the amount of time spent in the open area of the tanks was assessed. The two groups were then tested for their speed at acquiring a basic learning task in the open area of the tank to determine if shy individuals that are less likely to be in the open would be slower learners than bold fish. The reward for performing this task may differ between bold and shy individuals if they adopt different strategies to obtain the food reward and hence the success rate was compared between the two groups.

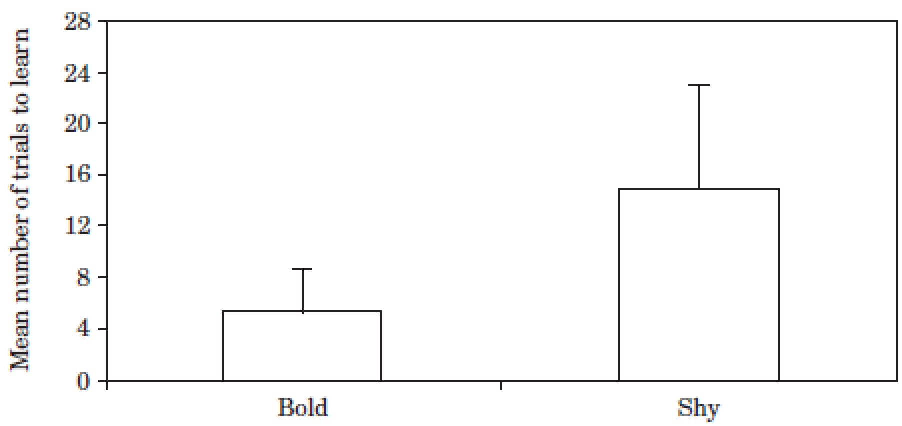
Hatchery-reared rainbow trout (n=42; 70–120 g) were obtained from a commercial fish supplier. The fish were housed individually in glass tanks (45x25x25 cm) with a constant supply of filtered fresh water maintained at 11 range $\pm 1^{\circ}$ C. Each tank had a gravel substratum and an internal filter (Interpet Series 1), and air was constantly bubbled through the water via an air stone connected to an oxygen pump by airline tubing. The tank had a transparent Perspex lid, half of which was covered by black opaque plastic (22x5x25 cm) and this provided a darker, covered area for sheltering. In the open area a white feeding ring (10 cm diameter), constructed from silicone tubing (0-1 cm diameter), was fixed to the side of the tank. The tanks were dimly lit from above and kept on a 9L: 15D photoperiod that was suitable for the time of year. Each tank was screened off from visual disturbance and observations were made through a small opening adjacent to each tank. Fish were held for 2 weeks upon transfer to the aquaria to allow them to recover from the stress of transport and become accustomed to their new surroundings.

Fish were individually trained using a simple conditioned response. The fish came to a feeding ring when a light was switched on to receive food pellets (commercial trout pellets, TROUW Aquaculture, U.K.). This light was positioned directly above each tank at a height of 1m from the top of the tank. A 20W bulb was used to provide enough illumination to cause the light levels in the tank to increase significantly. The position of the fish in the tank (i.e. in open or covered area) and frequency of swimming were noted for 15 min prior to training. The light was switched on and 2 s later 10 pellets were dropped into the feeding ring one at a time. The fish were trained twice a day, in the morning and afternoon. Their behaviour was noted during the training trial (i.e. position in tank and response to pellets), as was the number of pellets caught and ingested by each fish. Once the fish had learned the task (performance of three successful, consecutive trials) and was obtaining pellets, the fish were trained for a further 12 trials. This was done to assess strategy for obtaining pellets and efficiency of pellet capture.

The mean proportion of time spent in the open area was calculated for each fish from its position in the tank before each trial. Efficiency was calculated as the average percentage of pellets obtained in the last six trials. This allowed the fish six trials to become familiar with the task and to ensure the fish was fully trained. The number of trials for each fish to learn the task was determined and, to examine if there was any differences between the fish that employed a bold strategy and those that employed a shy strategy, a Kruskal–Wallis test was used to test the speed of learning with boldness and shyness. Kruskal–Wallis analyses were also applied to examine if average time spent in the open area, mean frequency of swimming and efficiency of pellet capture were different between bold and shy individuals.

Boldness and shyness were indicated by the way the fish captured pellets: once the task had been learned, bold fish (n=24) would respond to the light cue by waiting at the feeding ring and capturing pellets from the surface as they were dropped into the ring. Often the bold fish would actually jump out of the water to obtain a pellet. Shy fish (n=18) adopted a very different strategy. They waited in the covered area and swam out in a rapid fashion and obtained the pellet in midwater; after capture the shy fish returned quickly to the covered area and then repeated this movement to obtain further pellets. The strategy adopted by each fish was the same at each trial. Fish did not feed from the gravel during the observations and hence it is assumed that pellets that had been missed by the fish were not eaten. Those individuals that had been categorized as bold learned the task in fewer trials than shy fish (Fig. 1; $H_{2,42}$ = 22·34,P<0·001) although there were two shy individuals who learned in less than six trials. Bold fish spent a greater proportion of time before each trial in the open area than shy individuals (bold, mean 76·3±12%; shy, mean 6·2±7%; $H_{2,42}$=2902, P<0_001). Bold fish also swam more frequently than shy fish (bold, mean 1·2±01 min^{-1}; shy, mean 0·37±0·1 min^{-1}; $H_{2,42=}$40·0, P<0·001). There was a trend towards bold fish obtaining more food pellets than shy fish but this was not significant (bold, mean 65·5±5%; shy, mean 48·57%; P>0·05).

FIG. 1. Mean+S.E. number of trials to learn the conditioning task for bold (n=24) and shy (n=18) rainbow trout.



Boldness and shyness could be categorized in the rainbow trout by time spent under cover, swimming activity and the speed of learning a conditioning task. Bold fish spent the majority of their time in the open, performed a relatively higher frequency of swimming and took fewer trials to learn. Shy trout spent the majority of their time under cover, swam less and took longer to learn the task than did bold fish although two shy individuals did learn within six trials. Other studies have shown that such personality traits influence learning ability (Rekila et al., 1997). The results, however, could be interpreted as bold individuals being more willing to spend time in the feeding area and hence appear to learn more quickly than the shy individuals, who may be less willing to spend any length of time in the open area. This difference between motivation to be in the open area and actual learning ability needs to be explored further and should be taken into account when assessing the performance of an animal in a learning task. This could be assessed by repeating the experiment whereby the pellets are introduced into the covered area and speed of learning determined for the bold and shy trout to see whether shy fish are truly slower to learn.

Studies have sought to determine the ‘personality’ of animals and relate this to behavioural reactivity (Rekila et al., 1997) although relatively little attention has been paid to fishes. The present study has demonstrated that the proportion of time spent in the open and frequency of swimming were reliable indicators of boldness and shyness and could be used as a basic measure of the fish’s ‘personality’ and applied to other species. The strategy adopted during pellet acquisition was consistent within each individual and this was also a dependable indicator of boldness. Interestingly the pay off in terms of pellet capture was not significantly different between shy and bold fish in this experiment. This agrees with the suggestion that in order for both bold and shy strategies to persist in nature, both strategies must be successful (Wilson et al., 1993, 1994).

The stocking of depleted fish populations has been largely unsuccessful and this is a major welfare and economic concern. Studies have suggested that prerelease training has the potential to enhance survival skills of hatchery-reared fishes (Brown & Laland, 2001). Bold individuals that learn more quickly may be suitable candidates as role models for the social transmission of skills but this remains to be tested in the field. Fraser et al. (2001) found that bold fishes tend to disperse more widely upon release so shy fishes that generally remain at the point of release would not benefit from this practice. Therefore, it would be sensible to train both bold and shy fishes. Another possibility is to selectively breed rainbow trout and other commercial fish species for faster learning ability and this may enhance survivorship after restocking. It is of prime importance to release fishes that are better equipped to learn about a novel environment very quickly and thus, selection for fast learning ability may be vitally important and a key factor ensuring better survivorship and welfare of the released fishes and an improved economic return.

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