Legacy on Deck: Skill Transmission and Occupational Dynasties in the Royal Navy

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Abstract

Do occupational dynasties reflect the intergenerational transmission of skills or nepotism? We use detailed data on the fighting record of the 18th century Royal Navy to show that sons of navy officers are markedly more successful than non-legacies, outperforming in terms of enemy captures. This performance differential is not due to better equipment or more favorable assignments, and also holds for those whose patron has passed away. We provide evidence for positive selection as a channel through which the outperformance is sustained – sons of successful officers are more likely to join and be promoted in the navy. To examine the importance of vertical transmission, we use computer vision to analyze facial landmarks from over 1,000 portraits. We find that facial landmarks are predictive of success in naval warfare; officers with more masculine faces won more victories. Sons of service inherited these traits from their fathers and grandfathers, suggesting a possible channel for intergenerational transmission.

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1 Introduction

Occupational dynasties are common – children of actors, singers, lawyers, doctors, entrepreneurs, politicians, and faculty members are all vastly more likely to join the ranks of the same profession than the rest of the population.[1] Such patterns extend well beyond elite occupations, and include fishermen, aircraft mechanics, army privates, and librarians (Bui and Miller, 2017; George et al., 2025; Greenberg et al., 2024). Startlingly high rates of transmission of occupations are an important factor behind the intergenerational transmission of socio-economic status (Black and Devereux, 2011).

Determining the drivers of occupational persistence across generations is challenging. Dynastic occupational choice could be driven by the intergenerational transmission of skills, or by nepotism. While suspicions of "nepo-babies" being given a leg up by relatives are rife, job-related characteristics like risk aversion and patience are highly correlated across generations (Dohmen et al., 2012). In self-employment, families transmit crucial experience, financial capital, and industry know-how (Dunn and Holtz-Eakin, 2000); in the law profession, career-specific knowledge appears to be passed on (Laband and Lentz, 1992).[2] Parental advice and role model effects could also steer children towards the same profession – or persistent occupational choices could reflect direct nepotism.[3]

Ideally, we would measure on-the-job performance of parents and their offspring directly. We could then know whether the children of surgeons operate better, the offspring of lawyers win more cases, and whether the progeny of academics are more productive scholars – consistent with the intergenerational transmission of skills (either genetic or cultural). Alternatively, offspring might perform worse than their non-legacy counterparts – an empirical pattern consistent with nepotism. However, in most settings, we lack objective, quantifiable measures of on-the-job performance at the individual level – and even more so when it comes to high-stakes outcomes that can be observed across generations.[4] Without such indicators, distinguishing between the intergenerational transmission of talent on the one hand, and nepotism on the other, is impossible.

[1] See for example Dal Bó et al. (2009); Lentz and Laband (1989); Laband and Lentz (1992); Dunn and Holtz-Eakin (2000); Corak and Piraino (2011); Morgan et al. (2022); de la Croix and Goñi (2024).

[2] Evidence from adoption studies suggests a role for both cultural and genetic transmission for outcomes like years of schooling and college attendance (Björklund et al., 2006; Sacerdote, 2011a).

[3] Studies of medical school admissions, for example, suggest that the success of doctors' offspring cannot be fully explained by their credentials, pointing towards nepotism as a driver of high admission rates (Lentz and Laband, 1989). Along the same lines, quasi-random variation in tenure length among politicians appears to create self-perpetuating political dynasties (Dal Bó et al., 2009).

[4] One recent exception is de la Croix and Goñi (2024).

In this paper, we use unique data from the fighting record of Royal Navy captains over nearly 160 years to overcome this key measurement challenge. We show that sons of captains outperform their peers without such connections by a large margin. Positive selection – with the sons of successful captains becoming navy captains themselves – is one important determinant of this sustained outperformance. While favoritism and the use of connections was common in 18th century England, we find strong evidence for vertically-transmitted skills. Using a newly-assembled database of more than 1,000 portrait paintings, we show that success may in part reflect inherited traits. In particular, we show that sons' faces strongly resemble those of their fathers, and that identifiable features like masculinity, dominance, threat, and approachability correlate with naval success.

During the "long 18th century" (1690-1849), Britain was at war in one year out of three. The Royal Navy became the premier naval fighting force in the world. Royal Navy captains commanded ships with up to 900 men. Captains played a crucial role in British naval success. We measure individual captain performance by the number of enemy vessels seized or sunk — a verifiable, well-documented, and consequential indicator of performance. To distinguish between "sons of service" and non-legacy officers, we examine rich genealogical data, identifying naval dynasties. Combining the fighting record of officers with genealogical data, we compare the performance of sons of service and examine the intergenerational persistence of performance.

Raw capture rates by sons of service were on average approximately 50% per year higher. Naval engagements, however, were not won by captains alone – they needed the right ship, crew, and assignment. The availability of granular data on assignments allows us to decompose the drivers of outperformance. Strikingly, we find outperformance by sons of service across ship types and naval stations as well as assignments. No matter where the sons of naval officers were sent to fight, no matter what ships they commanded: sons of service sank, seized, or burnt enemy vessels at a higher rate. Even after we adjust for a large number of fixed effects including for ship, station, and crew, we still find outperformance by more than a third.

Despite the granular data allowing us to flexibly hold differences in assignments constant, there may still remain concerns that sons of service were given more opportunities to excel. Enjoying the support of a senior patron might result in more favorable assignments along margins that are not directly observed by the econometrician. We provide several complementary tests to allay such concerns. First, we examine "single ship duels" – chance encounters of two warships on the high seas. These are widely accepted as good indicator of fighting prowess, by both contemporaries and modern-day historians. The

Royal Navy generally excelled even when outgunned. Remarkably, the win rate of sons of service was consistently higher than that of non-legacies, especially when the odds were stacked against the Royal Navy ship. Second, we exploit plausibly exogenous variation in the timing of a father's death as a shock to network connections.[5] Only living fathers could directly lobby for better assignments or appointments. We show that the death of a father has or only small differential effects on performance for sons of service vis-à-vis non-legacies, suggesting that contemporaneous influence from a senior patron inside the navy was unlikely to be a key factor explaining the outperformance of sons of service. Finally, we repeat our analysis of performance differences using sons of MPs, who – given their relationship to influential MPs – likely enjoyed substantial favoritism. If elite connections in general explain the outperformance of sons of service, we expect to see similar outperformance of sons of MPs. In contrast to sons of service, however, sons of MPs do not outperform non-legacy officers. For these three reasons, we conclude that nepotism is unlikely to be a key driver explaining the outperformance of sons of service.

Positive selection is a likely underlying mechanism. The correlation of fathers' and sons' fighting record is substantial: the better a father's fighting record, the better the performance of his son. We thus study the role of selection at both the extensive and intensive margin. At the extensive margin, we collect extensive genealogical information on all children of Royal Navy officers. We can then examine the first step on the path to becoming a navy captain. In particular, we test whether the propensity of joining the naval service depended on the father's performance. Having served at sea, navy fathers might be better able to discern whether their sons had the "right stuff," or they may have produced more sons with the right traits. Consistent with positive selection, we find that sons of high performing fathers are much more likely to join the Royal Navy themselves.

Importantly, we observe the career trajectory of Royal Navy officers, who first had to pass the exam as lieutenant. With this in hand, they could take the second, decisive step on the ladder – being commissioned as a post-captain. We find that a lieutenant's chances were about 50% higher when their father was in the navy. This gap, however, is once again overwhelmingly driven by the sons of high-performing fathers – the sons of low-performing officers were, on average, not more likely to be made "post." As before, we find that whether an officer candidate's father had died or not by the time he came up for promotion did not differentially affect their chances of making post. This suggests an important role for positive selection in perpetuating the outperformance of sons of service.

[5]This approach is similar to Battaglini et al. (2024), who exploit the death of top donors to quantify the contribution of unobserved and non-monetary inputs to members of the U.S. congress.

Finally, we analyze which traits may have been passed on from father to son to explain the latter's outperformance. Naval warfare calls for a unique combination of talents, from mathematical ability required to navigate to the dexterity and judgment calls of seamanship, as well as the leadership skills necessary to lead hundreds of men into battle. Many captains came up short, and cowardice was a common problem in all 18th century navies (Rodger, 2005). Direct cultural transmission is unlikely to be a main driver – few sons of captains would have seen much of their father before going to sea themselves aged 12-14.[6]

To overcome the lack of direct measures of inheritable traits, we collected over 1,000 portraits of Royal Navy officers from major galleries and museums. Portraits of naval officers allow us to indirectly measure and study the role of inherited "traits" that might influence success in naval warfare. Leveraging recent developments in machine learning and computer vision, we use convoluted neural networks (CNN) to identify facial landmarks in portraits of Royal Navy captains. We first establish that facial features have substantial predictive power for naval success, approaching levels seen in modern-day data (Ludwig and Mullainathan, 2024). Several facial features differ systematically between high and low performing officers. To better interpret our finding documenting systematic differences in facial landmarks, we measure the masculinity of faces. Facial masculinity reflects in utero exposure to testosterone (Whitehouse et al., 2015); it is also known to correlate with greater aggression and competitive behavior (Carré and McCormick, 2008). We find that sons of service display facial features typically perceived to be more masculine, dominant, approachable, but less threatening than low performing officers. Importantly, sons of service share these facial characteristics of "winners" and their fathers, providing direct evidence for performance-related traits that are transmitted across generations.

Our findings relate to the literature on the causes and consequences of occupational dynasties. The majority of papers views occupational dynasties skeptically, finding evidence of negative performance effects. Professional managers, for example, have been shown to outperform family members (Bertrand and Schoar, 2006; Bennedsen et al., 2007; Burkart et al., 2003); ; sons of scholars publish less than other faculty members (de la Croix and Goñi, 2024); descendants of politicians and rulers are less successful (Asako et al., 2015; Bragança et al., 2015; George and Ponattu, 2019), and power itself may be self-perpetuating (Dal Bó et al., 2009). Our results offer a new perspective on the persistence of occupational dynasties. In particular, the outperformance of sons of service highlights the importance of positive selection as a channel through which the intergenerational transmission of skills

[6]For sons of service, the median number of years a father is away serving in the navy is 9 during the first 10 years of his life.

can lead to correlated performance – an empirical "existence result." Our paper is – to the best of our knowledge – among the first to study the intergenerational transmission of skills using a like-for-like, high-stakes measure.

More generally, we also relate to the literature on intergenerational mobility and the role of "nature" vs "nurture." Using detailed Swedish data, Björklund et al. (2006) find that both biological and post-birth (cultural) factors matter for the transmission of social and economic status. Chetty et al. (2014) show that better schooling, lower residential segregation, social capital, and family stability can reduce hysteresis in income ranks. Sacerdote (2011b) reviews the twin study and adopted children literature and examines the relative contributions of genetic and cultural factors.

Our results also contribute to the literature on the economics of recruitment and promotion. A growing body of work focuses on the role of selection (Dal Bó et al., 2013), studying geographical (Fisman et al., 2020), partisan (Colonnelli et al., 2020), race and gender (Mocanu, 2022; Moreira and Perez, 2022; Aneja and Xu, 2024), family (Xu, 2018; Riano, 2023), or other dimensions of homophily in explaining differences in entry or promotion. There is also an evolving literature on the personnel economics of state employees (Finan et al., 2017; Besley et al., 2021). Focusing on large samples of bureaucrats with different occupations, this research often relies on proxies such as education, previous wages or aggregate office-level measures to indirectly speak to the consequences of differential recruitment. Our focus on naval leaders, in contrast, enables us to directly measure individual on-the-job performance. In a related paper, we study the efficacy of discretion in promotion decisions made by the Admiralty of the Royal Navy (Voth and Xu, 2022). In this paper, we focus on the importance of the intergenerational transmission of performance-related traits to explain the outperformance of sons of service within the Royal Navy.

More generally, we also add to the literature on the origins of the Royal Navy's success (Rodger, 2005; Allen, 2005; Pope, 2013; Dull, 2009; Benjamin and Tifrea, 2007). The combination of rich data on personnel and performance allows us to take a systematic quantitative look into the inner workings of the Royal Navy. By doing so, we also contribute to the literature on the determinants of selection and effort in a military setting (Ager et al., 2022; Caprettini and Voth, 2022; Qian and Tabellini, 2022; Greenberg et al., 2024).

Finally, our paper is related to psychological and social science research using information from images and portraits (Todorov, 2017; Voth and Yanagizawa-Drott, 2024; Adukia et al., 2023).[7] Our computer-aided facial analysis is methodologically related to Ludwig

[7] Todorov et al. (2005), for example, uses portrait data to show that the perceived competence of politicians predicts electoral success; Rasmussen et al. (2023a) demonstrate that facial features can likewise predict

and Mullainathan (2024), who show that bail decisions of judges reflect facial features, and Safra et al. (2020). The fact that facial characteristics in our data predict military performance echoes the finding of Mueller and Mazur (1996), who show that dominance perceptions of West Point cadets' portrait pictures are an important predictor of later military rank.

2 Historical background and context

2.1 Size, organization, and career progression

The Royal Navy was central to British military power and absorbed a large portion of military spending. Between 1690 and 1810, the fleet expanded from 147 to 752 large vessels. During the Napoleonic Wars, manpower peaked at over 160,000 sailors and marines. Operating each ship incurred substantial costs (Brewer, 1990). Expenses included sailor wages, naval equipment (sails, ropes, masts), provisions, and munitions (Baugh, 2015; Allen, 2018). Naval officers typically began service at age 10-12. After a minimum of six years, they could be examined for promotion to lieutenant before a committee of captains (Pope, 2013). Lieutenants served under senior captains on large warships or commanded smaller vessels independently (Allen, 2002). The next step on the ladder was to be given independent command of larger vessels, i.e. promotion to post-captain (i.e. appointment to a "post-ship"). This was the single most important step in an officer's career; thereafter, if they lived long enough, they would reach the rank of admiral as promotion was by seniority. Appointing the right post-captains mattered for the Navy's performance: "the country in wartime [was saved] by giving outstanding men rapid promotion . . . the right men ended up in the right jobs" (Pope, 2013).

Almost half of lieutenants never reached the rank of post-captain. Gallantry in action boosted promotion prospects: "For a young officer who hoped for command, or for post-rank, nothing was more swiftly effective than to take an enemy ship of equal or greater force" (Rodger, 1987, p. 295). Post-captains then progressed from commanding 20-32 gun frigates with 150-250 men to 74-100+ gun battleships with 900-950 crew (Baugh, 2015).

While performance mattered, the use of connections and "influence" in promotions was also frequent. Patronage was considered normal in the 18th century – indeed, the use of merit-based criteria in the Royal Navy was widely held to be an aberration in wider

political orientation.

British society (Wilson, 2014).

2.2 Sons of service and career progression

The recruitment and continued advancement of "sons of service" was generally considered an honorific and beneficial practice in the 18th century Royal Navy. It formed part of a wider set of rules and norms governing navy appointments; like almost all social interactions involving desirable appointments in short supply in the 18th century, connections and patronage mattered (Rodger, 2005, p. 512). There are well-known cases – such as that of the renown frigate captain and later admiral, Edward Pellew – who successfully lobbied for their sons to be given early advancement (Taylor, 2014). Such requests carried weight. For example, Admiral St. Vincent, when recommending a junior officer, wrote to the head of the Admiralty, Lord Spencer (Morrow, 2018, p.188):

> '[he] is a child of the service, being the son of an old captain...; I feel it a duty to take care of the offspring and near connections of my brother officers.'

At the same time, being a son of the service did not guarantee promotion or a ship. St. Vincent, when First Lord of the Admiralty, turned down a request on behalf of sons of the service because "...it cannot be expected that I should attempt to break through a system to serve them at the expense of a very large number of meritorious officers who have highly distinguished themselves" (Morrow, 2018). There are numerous cases of admirals and captains having their requests on behalf of their own sons turned down. Being connected to a Royal Navy captain was simply one of the many dimensions in which a young officer could accumulate "influence." It was not fundamentally different from other factors allowing access to and claims on the favor of potential patrons.

Patronage in the Royal Navy had a meritocratic side (Rodger, 2005). Historians have argued that the use of information derived from personal connections ("patronage") facilitated selection based on ability. In many cases, it did not privilege the well-connected, but facilitated the rise of men from humble backgrounds (Rodger, 2005). The extent to which senior service leaders intervened on behalf of juniors was always tempered by concerns over their own reputation and future ability to influence decisions (Morrow, 2018, p.192):[8]

[8]Likewise, fathers who intervened on behalf of their sons put great pressure on them to perform. For example, after Lord Radstock lobbied the Admiralty on behalf of his son George, he wrote to him that his "first ambition after that of meriting the esteem of the World must be that of shining in your profession" (Morrow, 2018).

> "Merit and interest overlapped when the meritorious built up stocks of professional support reflecting senior officers' and officials' personal admiration and appreciation of an officer's future value to them and the service."

2.3 Success in the Age of Sail

European navies all used very similar technology (Allen, 2002; Rodger, 1987). Yet, battle outcomes were lopsided – during the Napoleonic Wars, for example, the Royal Navy lost 166 ships while destroying 1,201 enemy vessels, a 7:1 ratio (32:1 for battleships) (Allen, 2002). Leadership was crucial: many captains could either avoid combat or engage aggressively. Regulations enforced strict discipline. Cowardice even among captains was "a real problem" (Rodger, 1987, p. 244). The Royal Navy even executed an admiral for lack of aggressive action. The Royal Navy's advantages included merit-based commissions, strong financial incentives in the form of "prize money" for ships seized (Rodger, 1987) and access to skilled merchant sailors, sometimes through impressment (Allen, 2002).

3 Data and descriptive statistics

3.1 Personnel, ship and station data

Our core data are from Threedecks,[9] a web resource on navies during the Age of Sail. It contains information on 30,843 ships, 40,278 seamen, and 1,085 actions and battles among European sea powers.[10] We use Threedecks' information on the Royal Navy to construct our main dataset, restricting the sample to the period 1690–1849. We combine individual-level data for officers (lieutenants, commanders, post-captains) with a ship-level panel to construct a matched "ship–officer" dataset. The dataset contains rich information on the number of actions undertaken, the number of enemy ships captured or destroyed, and whether the ship itself was captured, wrecked, or sunk.

We complement the Threedecks data with newly digitized station lists covering the period 1690-1849. These provide information about ships and vessels in commission, by assigned naval station and task.[11] We link these records to our core data to obtain a panel

[9] http://www.threedecks.org

[10] We extracted the data in October 2025; the numbers are correct as of that date. The dataset is maintained by naval enthusiasts; it is a trusted source referenced by the National Maritime Museum in Greenwich.

[11] These records are available in the UK National Archives under ADM 8 – Admiralty: List Books. We digitized the lists on annual basis for the reference month of January. See Figure A1 for a sample.

that allows us to track officers, their assigned ships and geographical location over time.

Our data is comprehensive and accurate: it covers more than 95% of ships listed in other sources (Colledge and Warlow, 2010); in a random sample of 1% of the officers, we checked careers against standard references (Clowes et al., 1897; Syrett and DiNardo, 1994) and found no meaningful discrepancies. The final dataset contains information on 3,904 ships and 5,848 officers in the Royal Navy over 160 years – a total 82,958 officer-ship-year observations. At the peak, we can reference 500 fighting events per year and connect them to 1,500 officers. Table 1 shows summary statistics. The average officer serves on 3.5 different ships with an average of 32 guns. An officer remains in the Royal Navy for an average of 12.5 years and commands a ship for 6.4 years. More than half of officers attain the rank of post-captain.

Performance is generally well-recorded and objectively measured: the capture and the sinking of enemy ships.[12] Naval officers kept detailed ship logs; events like the sinking of an enemy ship were widely reported. On average, each officer could claim one victory, but the distribution is highly skewed.

3.2 Sons of service in the Royal Navy

We rely on three data sources to identify sons of service. First, we use the family network information directly provided by Threedecks. Second, we match officers in our core dataset to genealogical data from Ancestry.com. Third, we match officers in our core data to genealogical data from the Peerage dataset (Xu, 2018). We then pool across all data sources to construct a comprehensive measure identifying sons of service. Table A1 provides more details about the pooling.

We define "sons of service" as an officer whose father, grandfather, or uncle is a naval officer. By our measure, we identify 547 naval officers in our sample (or 9.4%) as sons of service. For robustness, we also use a narrow definition, where we only consider those with fathers in the naval service as sons of service. This narrow definition results in a lower number – 338 naval officers.

The genealogical data we use is high quality and unlikely to induce false positives. While false negatives are more of a concern, pooling across all three data sources ensures that we obtain the most comprehensive coverage possible.

Figure 1 shows the share of sons of service over time. It rises gradually. By the end

[12] Both sinkings and captures reflect the success of naval captains. We therefore combine them into a single indicator of performance, which we call "victories."

of our sample period, 40% of the naval officers are either sons, grandsons, or nephews of naval officers. The dashed line plots the share of post-captains who have a father in the navy. While lower, we observe a similar increase over time. Compared to an average British man, the chances of a captain's son to serve as captain in the Royal Navy is approximately 132 times higher.[13]

[Figure 1 here]

The increase in sons of service over time is striking. Does this reflect their greater suitability for naval service, or increasing nepotism? If the rise of sons of service reflects the former, we expect sons of service to outperform non-legacy officers. In contrast, if the rise of sons of service reflects nepotism, we expect them to underperform relative to non-legacy officers. We will use similarly well-connected officers (related to members of parliament) to isolate the effect of connectedness from the transmission of talent.

4 Sons of service and performance

In principle, sons of service may enter the navy in high numbers because of the value of family connections, facilitating their rise to positions of power independent of ability ("nepotism"), because of superior information about what traits and abilities were necessary to succeed ("information costs", or social capital), or because they are simply better naval officers (with potential roles for tacit or explicit human capital transmission from father to son, or because of inherited abilities).

We now explore how sons of service fared at sea relative to non-legacies. Figure 2 plots the average annual capture rate for officers commanding any ship, before and after promotion to post-captain (at time t=0). Sons of service outperform as soon as they are in command, and the gap only grows over time in the run-up to promotion to captain. Afterwards, the average performance of all captains rises for a few more years, before starting to decline as they are reallocated towards larger vessels with – typically – lower capture rates.[14] Even when commanding bigger vessels, sons of service continue to outperform at a healthy rate. Over their career, each son of service captured an average of 2.2 enemy vessels, whereas the non-SoS officers captured an average of 0.72.

[13] A rough calculations suggests that 0.4% of English men served as Royal Navy officers. In the US Army, having a parent that serves approximately doubles the likelihood of offspring joining (Greenberg et al., 2024). George et al. (2025) compile similar statistics for countries today, and find even higher numbers in some professions.

[14] Capture rates overall were highest for frigates (cf. Figure 4, fifth rate ships).

Sons of service are also vastly overrepresented among the highest performers – while only 9.35% of officers in our full dataset are sons of service, they account for 20.4% of the top 10 percent of capturing captains. Figure 3 plots each quantile of performance by sons of the service against the corresponding quantile by non-legacies. Performance is computed as the mean number of captures and enemy ship sinkings per year. The performance distribution of sons of service first order stochastically dominates the distribution of non-legacies. We can easily reject the equality of both distributions. Once we standardize for navy-wide captures in each year, the gap between legacy and non-legacy officers is equivalent to more than a full standard deviation of captures. In other words, sons of service are about three times more likely to be top-performers than ordinary officers. In every regard, sons of service vastly outperform non-legacies.

[Figure 3 here]

What explains the superior performance of sons of service? The performance gap between sons of service and non-legacies could be driven by superior inputs. With a patron in the service, sons of service could – everything else equal – be favored in the assignment of better ships, crew, or stations. They could also have had more of the "right stuff," a mix of characteristics necessary for successfully directing a warship and leading hundreds of men into battle. Such skills could be inherited or accumulated more quickly by sons of service who – growing up in a naval family – may benefit more from job-specific mentoring. Here, we try to unpack the drivers of outperformance.

4.1 Drivers of outperformance – favorable assignments

We use the rich data to directly test whether the greater performance of sons of service is driven by better equipment, crew, or more favorable assignments. Figure 4 reports the performance of sons of the service and other officers, by ship type and station assignment. Panel (a) shows the performance gap between sons of service and non-legacies for each ship class. Ships of the Royal Navy varied greatly in size. The largest ships, first and second-rate vessels, had gun count from 80 to over a hundred. At the other end of the spectrum, unrated ships had a median gun count of only 16. As panel (a) shows, the bulk of the captures and sinkings is concentrated among the lower rated ships, which were often detached for independent service. Larger ships, in contrast, often sailed as part of "blocking squadrons," blockading enemy vessels in port with fewer possibilities for captures. Strikingly, we observe the outperformance of sons of service across nearly all rates.

In fifth rates (i.e. frigates) – the type of vessel with the highest capture rate overall – the outperformance is the largest in relative terms. Rather than driven by the preferential assignment of sons of service to ship classes with greater opportunities, we conclude that there is a substantial performance gap across almost all types of vessels, with sons of service outperforming non-legacies assigned to the same-rated ships.

Panel (b) breaks down the performance gap by the major stations. Once again, opportunities to capture and sink ships varied by assignment. Importantly, however, the superior performance of sons of service relative to non-legacies remains substantial. For the Coast of Ireland station, for example, the mean capture rate of sons of service was almost four times higher than the rate of non-legacies.

[Figure 4 here]

To more precisely quantify the effect of observable inputs on the performance gap between sons of service and non-legacies, we estimate the following regression model:

$$y_{it} = \beta \times \text{SoS}_i + \gamma' x_{it} + \tau_t + \kappa_{K(i,t)} + \varepsilon_{it} \tag{1}$$

where y_{it} is the performance measure for officer i and year t. In our main specification, y_{it} refers to the number of victories – the total number of enemy ship captures and sinkings – by officer i in a given year t.[15] $\text{SoS}_i = \{0, 1\}$ is a dummy that is 1 if the officer is a son of service – defined by having a father, grandfather, or uncle serving as a naval officer – and 0 otherwise. τ_t are year fixed effect, accounting for common shocks (e.g., wartime vs. peacetime) across all officers serving in a given year. $\kappa_{K(i,t)}$ are tenure fixed effects, where $K(i,t)$ returns the years of service for given officer i at time t.

Our main coefficient of interest is β, which captures the differential performance between sons of service and non-legacy officers. To assess the extent to which the outperformance of sons of service is driven by differences in inputs, we gradually include as the vector x_{it} a range of granular fixed effects that flexibly account for major margins of assignment. Finally, we cluster standard errors at the officer level i, corresponding to the level at which our comparison – sons of service vs. non-legacies – varies.

[Table 2 here]

Table 2 reports the main results. Consistent with the raw comparisons (Figure 3), sons of service significantly outperform their non-legacy counterparts. In column 1, we report

[15] Our results are also robust to alternative definitions of the outcome variable, see Table A2.

the baseline specification including only year and tenure FEs. Among post-captains, for example, sons of service capture on average 0.113 more enemy ships per year. Compared to the mean capture rate, this corresponds to a increase by a staggering 84%.

In columns 2–4, we assess the extent to which the outperformance of sons of service may be driven by the assignment to more preferential ships. In column 2, we include ship rate FEs (see panel (a) of Figure 4) to restrict the comparison of the sons of service vs. non-legacy performance gap to those within the same ship rate. In column 3, we go even further by exploiting the fact that the same ship is assigned to different captains throughout its lifecycle. This allows us to include ship FEs, comparing the outperformance of a sons of service vs. a non-legacy officer in command of *the same ship*. This, for example, takes into account that some ships are equipped with more guns, or are of superior design. While the performance gap declines, in line with the assignment of sons of service to higher performing ships, the magnitude remains large, corresponding to a gap of 53% relative to the mean capture rate.

Ships are important, but so is the crew. While the ability to attract a higher performing crew might reflect superior leadership, the granular data allows us to quantify the extent to which differences in crews might matter. In particular, the data contains information on when the crew was *paid off*, allowing us to construct a ship $\times$ crew FEs that holds both the ship *and* its crew constant. Even with this very restrictive set of fixed effects, the performance gap between sons of service and non-legacies remains (column 4). Finally, we can make use of our newly digitized data on station assignments to restrict the comparison to sons of service and non-legacies serving at the same station (see panel (b) of Figure 4). While the sample size declines somewhat due to the lack of station data for all assignments, the outperformance gap remains large and statistically significant – if anything, increasing in size. We conclude from this decomposition exercise that the greater performance of sons of service cannot be explained by differences in the assignment to ship, crew, and stations. Even adjusting for differences in this broad set of inputs, we find a performance gap for sons of service of around 40%.

4.2 Enemy fighting power and captures

Despite the rich set of fixed effects that flexibly hold differences in assignment constant, some concerns may remain that the superior performance of sons of service reflects favorable assignments, even when using the same ship, crew, and serving on the same station. A simple way to sidestep such concerns is to consider individual encounters. When two

enemy vessels met on the high seas – typically by chance – and battled each other, we have a direct test of relative fighting prowess. Contemporaries considered the outcome of these duels the best indicator of relative fighting ability in naval warfare.[16]

What determined success in these duels? After taking into account the relative strength of vessels involved – best proxied by the number of their guns – it is overwhelmingly the seamanship of the captain and crew, and their fighting prowess, that determines success. Here, we examine the probability of a successful capture for sons of the service and non-legacies, taking into account differences in relative fighting power. If naval officers who were sons of service were better captains and leaders of men, they should have won more often than non-legacies, when faced with an enemy vessel of comparable relative gun strength.

Figure 5 plots the "win rate" as a function of the relative gun count, where 0.5 indicates a duel between evenly matched ships. We restrict the sample to the gun count range for which we observe captures by both sons of service and non-legacy officers, giving us 571 in total. In general, the Royal Navy excels in captures – for evenly matched engagements, the Royal Navy easily wins more than 90% of the time. Importantly, however, we find that the success rates for sons of service are consistently higher than the rates of non-legacies. For example, when the enemy vessel has 50% more cannons than the British vessel, the win rate for non-legacies is 0.75; for sons of service, it is 0.92. These differences across the range of relative fighting power are statistically significant (Appendix Table A3). In other words, while Royal Navy captains mostly won in individual encounters, son of service won almost all of the time, even when substantially outgunned. This result strongly suggests that favorable assignment was not the driver of sons-of-service outperformance. Instead, their high success rate strongly suggests that they made better officers, even with chance assignments and accounting precisely for differences in fighting strength.

[Figure 5 here]

4.3 Contemporaneous influence of fathers

Sons of service might benefit – at least in part – from performance-enhancing factors that are not directly observed by the econometrician. For example, senior naval officers might intervene to obtain a ship or a favorable assignment for their sons, or provide mentoring. While these "softer" inputs are not readily observed, we can leverage unexpected shocks

[16]For example, when American frigates destroyed and seized Royal Navy frigates during the War of 1812, this caused much British anxiety over a sudden decline in naval supremacy (Rodger, 2005).

to the presence of one's father to indirectly measure the contributions of such unobserved factors. Specifically, we exploit variation in the timing of the father's death – conditional on the father's age. Note that very few RN captains actually died in battle. betweenBetween 1660 and 1815, the combat fatality rate among British navy captains fell by 98 percent; the variation we use is driven by natural causesBenjamin and Tifrea (2007). If naval patronage and mentoring on the job were decisive for the naval record of sons of service, we would expect that a father's sudden death should cause a sharp decline in performance. In contrast, if ability and seamanship are an important determinant of naval victories, we expect to observe a persistent outperformance of sons of service even after their fathers passed away.

[Table 3 here]

The results are reported in Table 3. Column 1 reports the full sample, preferred specification, corresponding to column 5 of Table 2. In column 2, we include a dummy equal to 1 if the officer's father has died. We condition on the father's age and the year of his death to more explicitly exploit a plausibly more exogenous source of variation in the timing of the father's death. The result suggests that the father's death does not significantly affect an officer's performance. More importantly, the impact of parental death does not vary significantly by whether the father was a navy officer or not (column 3). While the point estimate for the interaction suggests a larger decline in performance for sons of service, the coefficient is modest in size and imprecisely estimated. In fact, we continue to observe the outperformance of sons of service even after their fathers passed. In column 4, we further include officer fixed effects to leverage within-officer variation in the timing of the father's death, conditional on age. While the inclusion of individual fixed effects increases the magnitude of the coefficient, the point estimate is too noisy. The differential effect of paternal death for sons of service is indistinguishable from zero.[17] This suggests that the presence of fathers is not a key driver of the outperformance of sons of service.

4.4 Placebo test – sons of MPs

Could elite connections in general explain the outperformance of sons of service? Even the most senior navy officials were constantly bombarded with requests for favors on the behalf of protéges – Lord St. Vincent, when Head of the Admiralty, complained that "at

[17] Appendix Figure A3 provides the corresponding visual evidence for an event window around the father's death.

present the Navy is so overrun by the younger branches of nobility, and the sons of Members of Parliament and they so swallow up all the patronage and so choke the channel to promotion, that the son of an old Officer, however meritorious both their services may have been, has little or no chance of getting on." (Rodger, 2005)

A useful placebo test is therefore to look at the sons of Members of Parliament (MPs). Then as now, MPs are highly influential politicians. In a world in which patronage was a fact of life, sons of MPs likely enjoyed substantial advantages. Indeed, the historical literature regards them as highly favored in terms of assignments – arguably even more so than sons of the service (Morrow, 2018). If the ability to twist the arms of senior naval officers was enough to ensure success on the high seas, sons of MPs should look like the sons of service – similarly outperforming non-legacies. They do not.

In Figure A2, we first plot the share of sons of MPs over time. Initially, there were more sons of MPs than sons of service in the Royal Navy. Eventually, however, this pattern reverses as the share of MP offspring stagnates and even declines over time. In contrast to the sons of service, sons of MPs (Table A4) do not outperform normal officers. Even if the point estimate is positive, the magnitude is economically small — 1/1000th of an annual victory — relative to the large outperformance of sons of service. Despite having more elite connections than sons of service, we find that sons of MPs do not outperform by a significant margin.

5 Sons of service and selection

In the previous section, we provided evidence that the outperformance of sons of service cannot be explained by better inputs (e.g., more powerful ships) or more favorable assignments (e.g., high capture stations, more favorable gun ratios).

We now turn our attention to an additional explanation of the outperformance of sons of service – positive selection. Having served at sea, navy fathers might be better able to discern whether their sons had the "right stuff." If high performing fathers are more likely to guide their most suitable sons into naval service, the perpetuation of occupational dynasties within the Royal Navy will induce positive selection.

5.1 Father performance and selection into the Navy

Testing the presence of positive selection into the Royal Navy requires data on the pool of potential children who *could have* joined the navy. We collect data from ancestry.com on

the children of RN officers. This enables us to examine what share of an officer's offspring joined the navy. For each officer i, we estimate:

$$\text{Navy}_i \quad = \quad \beta \times \text{High perf}_i + \theta_{T(i)} + \nu_{N(i)} + \varepsilon_i \tag{2}$$

where Navy_i is a dummy that is equal to 1 if officer i has *at least one* son in the navy, and 0 otherwise. High perf_i is a dummy that is 1 if the officer i is high performing and 0 otherwise. We define high performing in two ways: whether the officer made post in his career, or captured any enemy vessels. $\theta_{T(i)}$ are officer entry year FEs that restrict the comparison to officers of the same vintage. $\nu_{N(i)}$ are fixed effects for each number of sons that the officer has. ε_i computed heteroskedasticity-robust standard errors.

The results are reported in Table 4. Consistent with positive selection, sons of higher performing fathers are significantly more likely to enter the navy. Sons of fathers who made post (column 1) or captured enemy vessels (column 2) are 6.3-7.6 p.p. more likely to be in the navy, effectively doubling the chances (compared with the offspring of mediocre officers). In column 3, we pool both performance measures into a single combined indicator that measures whether the father *either* made post *or* captured enemy vessels. Figure 6 shows the visual evidence consistent with selection. The figure reports the fraction of children who enter the navy as a function of the total number of children, broken down by whether the father was high performing or not. The likelihood of having sons join the navy increases with their number. For any given number of offspring, sons of high performing fathers are much more likely to join the navy than sons of low performing fathers.

[Table 4 and Figure 6 here]

The remaining columns of Table 4 compare the positive selection due to the father's performance against whether the father is a son of service – a legacy officer – himself. Being a son of service increases the chances of one's son to join the navy as well (column 4). Interestingly, however, this impact is independent from the father's performance (column 5). Overall, the observed patterns are consistent with sons of service being positively selected.

5.2 Sons of service, father performance and promotion to post

The rich personnel records allow us to not only test for positive selection at the entry margin but also to examine positive selection in career progression. We do this by asking whether sons of service also rise more quickly through the ranks of the navy.

Sons of service have markedly higher promotion rates than other officers. Only 75 out of 338, or 22%, of sons of service were not promoted to post-captain; but a full 49% of other failed to take the decisive step in a naval officer's career. As Figure 2 shows, sons of service already captured more enemy vessels *before* they were promoted to post-captain, conditional on commanding a vessel; outperformance occurred even when they served as commanders, before they were given charge of a major warship.

To investigate the differences in career progression, Figure 7 reports the survival analysis for the promotion to post-captain. The figure plots the proportion of officers who are yet to be promoted as a function of years of service. While the chances of promotion increase over time, promotion to post occurs faster for sons of service. Strikingly, we find that sons of high performing fathers are promoted much quicker than sons of low performing fathers, consistent with positive selection. Sons of low-performing captains, on the other hand, are much closer to the unconnected in terms of promotion prospects.

[Figure 7 here]

We can corroborate the survival analysis with regressions predicting promotion to post depending on an officer's legacy status. To do so, we restrict the sample to all unpromoted officers. We then regress the likelihood of being promoted in the next period as a function of the legacy status and father performance, conditioning on tenure and year fixed effects to compare the officers of the same vintage. The results are reported in Table 5. Consistent with the visual evidence in Figure 7, sons of service are significantly more likely to be promoted at any given point in time. Holding the years of service as well as the year constant, sons of service are 4.6 p.p. more likely to be promoted than their non-legacy counterpart. With the unconditional promotion probability at 8.1%, this is a sizable increase.

[Table 5, Table 6 here]

In columns 2–4 of Table 5, we formally test for positive selection by distinguishing whether the navy father was a high performer or not. Consistent with positive selection, we find that sons of high performers are more likely to be promoted. This holds using both measures of performance (columns 2–3), as well as the combined measure (column 4). Therefore, sons of service who join the navy are not only more likely to be sons of high performing fathers; it is also the case that sons of high performing fathers (in the navy) are more likely to be promoted to the higher levels of command.

Are the greater chances of promotion due to the contemporaneous influence of the father? If high performing fathers affect promotion decisions directly, we expect the positive

selection pattern to vanish once we restrict the sample to sons of service whose fathers already died. Interestingly, we find that the positive selection pattern in career progression holds irrespective of whether the father is alive or not (Table 6, columns 2-3). Living low-performing captains are negatively associated with their prodigy's promotion prospects. This makes it less likely that direct nepotism, exerted by a living father, is the key driver for the fast career progression of the sons of naval officers. It cannot rule out indirect forms of nepotism, such as an institutional bias towards promoting sons of officers. The combined evidence strongly suggests a role for positive selection in driving the outperformance of sons of service.

5.3 Post-promotion performance by war vs. peacetime promotions

Finally, we revisit the post-promotion performance gap between sons of service and non-legacies by exploring heterogeneity. Periods of war greatly increased the demand for captains, providing plausibly exogenous variation in the extent to which a lieutenant or commander is likely to be promoted to post-captain. These episodes of heightened demand are also periods where the return to connections is likely to be lower. If sons of service who make post during these war-driven promotion surges – when connections are less likely to play a role – still outperform their non-legacy counterparts, it would provide further evidence in favor of their superior performance.

We study the heterogeneity in Table 7. To begin with, column 1 confirms that promotion odds greatly increase among yet-to-be promoted during periods of war.[18] Compared to the unconditional promotion rate, years of war increase the promotion probability by 18%. Columns 2–3 break down the post-promotion performance of sons of service vs. non-legacy officers to officers who were promoted during war and peace periods. Strikingly, and consistent with the superior fighting ability of sons of service, sons of service outperform their non-legacy counterparts both for promotions made during war and peace-time. The coefficients are comparable in size and we cannot statistically reject the equality of both coefficients. The fact that sons of service who made post during war-driven promotion surges (when connections are less important) continue to outperform post-promotion suggests superior aboility and selection of sons of service.

[Table 7 here]

[18] We define a period of war as a year where the total number of captures is above the average over the entire sample period of 1690–1849.

6 Transmitted Individual Traits and Success

Why do the sons of service outperform? Many traits are transmitted from parents to children, including risk preferences and time orientation (Dohmen et al., 2012). In our setting, personality traits cannot be measured directly. A growing literature establishes robust correlations between physical features, (perceived) character, and individual outcomes (Todorov, 2017; Ludwig and Mullainathan, 2024; Eberhardt et al., 2006; Little et al., 2007). We use historical portraits and extract facial features that are plausibly related to underlying traits. These predict combat performance.[19] Sons of service differ markedly from non-legacies in terms of these facial features, and they resemble their fathers. This provides suggestive support for intergenerational transmission of successful traits.

Advances in machine learning (ML) allow us to systematically analyze historical portraits at scale, providing a unique window into the physical characteristics of naval officers. We first demonstrate that facial features have substantial power to predict naval success. Next, we document that more successful officers have more masculine faces, suggestive of higher testosterone levels—a known correlate of aggressive behavior; as well as higher approachability and dominance scores, while being perceived as less threatening. Finally, we show that sons of service display these traits associated with success while resembling their fathers. Their facial features, on average, are more similar to successful captains than to unsuccessful ones, suggesting a biological mechanism for the transmission of (perceived) naval talent.

6.1 Collecting and analysing portrait paintings

Many accomplished merchants, bureaucrats, and military men had their portraits painted in the past. We systematically examine the collections of museums and portrait galleries, assembling a comprehensive database of 1,069 Royal Navy officer portraits, corresponding to 685 officers. For each detected face, we record the landmark coordinates normalized by image width, height, and position.[20] After automated image-quality diagnostics and manual review of facial landmark placement, 914 portraits of 595 captains remain.[21] Offi-

[19] While faces may not "reveal" behavioral characteristics, humans plausibly react to facial features in a way that creates self-fulfilling expectations. This may be particularly true of masculinity, dominance, threat, and trustworthiness (Todorov and Oosterhof, 2011; Todorov, 2017).

[20] We use the dlib's facial landmark detector and shape predictor, which is based on Kazemi and Sullivan (2014)

[21] Of these 914 portraits, 840 pass the dlib-based landmark review directly. For another 74 portraits we recover landmarks using 3DDFA, a three-dimensional facial landmark extraction method that is better suited

cers not serving in wartime are excluded. The final sample contains 876 portraits and 564 captains.

Portraits do not come from a random sample of officers. Paintings were commissioned either by officers themselves or wealthy patrons. As Table A6 shows, selection into having a high-quality portrait is—perhaps not surprisingly—positive and correlated with success, birth, and connections. Sons of service are more likely to have a portrait; so do post-captains and admirals. Despite the non-random collection of portraits, the comparison of physical features between sons of service and non-legacies will still be valid as long as selection into having a portrait painted does not vary differentially by legacy status. Assuringly, as Table A7 shows, there is no evidence that legacies with similar observables had fewer portraits painted than other officers.

Paintings often show the officer in uniform, frequently on deck or in front of a naval landscape; the uniform, medals, and setting may contain hints of the officer's success (e.g., Figure A5). To sidestep issues that could arise from analyzing the full picture, we (i) focus on cropped faces (ii) only extract 68 facial landmarks from each image. These are basic physical features such as the position of the corners of the mouth, the nose, etc. These can then be used to derive other indicators approximating facial shapes. Figure 8 shows an example from a painting of Captain Thomas Harrison, who commanded sloops, frigates, and a ship of the line, serving in the Royal Navy from 1747 to 1766.

[Figure 8 here]

Paintings are not photographs. Do paintings reflect facial features accurately? We present three pieces of evidence. First, paintings and pictures of the same individual yield very similar information on facial landmarks. We collect 87 pairs of photographic pictures and portrait paintings depicting the same individuals. This includes Royal Navy captains but also other public figures like politicians and army officers, from the 1850s onwards. We score facial similarity (using the DeepFace/ArcFace model, based on the cosine distance as the similarity metric). In 77% of cases, the portrait photo and painting are correctly recognized as belonging to the same person. False positives are rare. In only 4.7% of cases is a random pair of picture and photo classified as a match. This confirms the validity of

for turned faces (Guo et al., 2020). It extracts the same 68 coordinate landmarks as the dlib library, however interpolates covered facial features using geometric inference. We normalize the coordinates obtained from the 3DDFA process to a frontal face. Figure A4 presents two examples of where the dlib landmark extraction fails and where the 3DDFA based approach can recover the landmarks. We only retain portraits for officers who also have at least one dlib-accepted portrait.

using portrait paintings to extract information about facial features.[22]

Second, painted individuals may be shown in a flattering light. There are also clear limits to such flattery—once facial features are distorted beyond the recognizable, little purpose is served by a portrait. We examine the similarity of portraits of the same person, leveraging the fact that officers are often painted at different ages. An example is given in Figure A7, showing two portraits – by two different painters – of George Byng, 1st Viscount Torrington (1663-1733), when Byng was 46 and 60 years old. We find that multiple paintings of the same officer score highest in terms of facial similarity. The high similarity shows that facial landmarks are relatively stable over time. Within-officer similarity in facial traits is higher than across-officer similarity (Figure A6). This suggests that portrait paintings of officers, while arguably affected by some artistic licence, capture distinctive facial features.

6.2 Predicting Performance

We train a machine learning model to predict officer performance using facial characteristics. From the extracted 68 landmarks, we construct 39 geometric features that capture relative distances and proportions of the face. To avoid overfitting, we reduce these features to 8 principal components.[23]

[Figure 9 here]

Our training data is split into "successful" and "failure" captains. The former have 4 or more non-fleet victories; the latter, none. We exclude victories scored as part of fleet actions, sieges, blockades, and similar engagements because they carry less information of an individual captain's ability. To ensure "failure" is not driven by lack of opportunities, we only use officers who were in command of a ship during wartime. Figure 9 shows examples of six naval officers – three without captures, and three successful ones. The training sample is then balanced, resulting in a total of 573 original portraits of 388 officers. We use data augmentation within the training folds: original portraits are augmented three times through horizontal flips, small rotations, and brightness/contrast perturbations, without changing facial structure. Model performance is evaluated using five-fold cross-validation, which corresponds to repeated 80/20 splits at the officer level. In each fold, 20% of portraits of a given set of officers are excluded from training, the model is trained on the remaining

[22]For further detail, please see the Appendix subsection A.3.

[23]Following the Kaiser rule, keeping only components with an eigenvalue greater unity.

officers and their augmented images, and predictions are then generated for the hold-out officers' original (non-augmented) portraits only. Thus, validation performance is based on out-of-fold predictions for original portraits of officers not used to fit the corresponding model. A random forest model with shallow trees performed best.

Figure 10 shows receiver operating characteristic (ROC) curves for the training and validation dataset. For random guesses, the curve would follow the 45° line; for perfect predictability, it would follow a rotated L. The standard measure of predictive performance is the area under curve (AUC). Successful predictions circumscribe a larger area above the 45° line. In-sample predictive performance is high. We observe an in-sample AUC of 0.673. Crucially, out of fold prediction performance is relatively high—we obtain an AUC score of 0.589 across the five-fold CV. While not perfect in its predictions, it performs markedly better than chance. Conceptually closest to our exercise is Ludwig and Mullainathan (2024), who predict incarceration from facial features and find an AUC of 0.63. In other settings, successful out of sample prediction exercises (such as in the case of party affiliation and US congressional speeches) obtain out-of-sample values of 0.53-0.54 (Gentzkow et al., 2019). This suggests that our simple method, using facial landmarks extracted from historical paintings, captures some relevant information about a naval officer's chances of success.

6.3 Correlates and Interpretation

Based on metrics derived from facial landmarks, our classification can predict success for an 18th century navy officer. Why would facial features contain information about this? The idea that facial features reveal "character" has a long and disputed lineage (Todorov, 2017). A number of papers in recent years has found that facial features predict attitudes like political orientation (Rasmussen et al., 2023b) as well as important outcomes, such as incarceration, the application of the death penalty, electoral success (Ludwig and Mullainathan, 2024; Eberhardt et al., 2006; Little et al., 2007), and military career progression (Mueller and Mazur, 1996).

To understand why facial features might matter, we need to understand the determinants of success in the Royal Navy. Two were key: Courage and recruitment. Cowardice among captains was a prime problem for all navies (Rodger, 2005); not all men found it easy to stand calmly on the quarterdeck while cannon shot pulverized their wooden ship at gunshot distance. Second, Royal Navy captains of the 18th century had to recruit their own crews. Once recruited, seamen would often have to serve for years, until "paid off". Navy discipline tended to be harsh, and captains were masters over life and death dur-

ing a seaman's period of service. While some captains resorted to impressment, the more successful captains tried to staff their ships with a large share of volunteers. Being perceived as approachable and trustworthy would have encouraged more and better volunteers. Arguably, being dominant, yet less threatening, would have been an asset. While a despotic captain could make his crew's life hell, a weak leader without the authority of command would have endangered his crew when sailing and fighting the ship. Men perceived as more dominant, yet competent and approachable, should have found it easier to lead skilled, motivated crews into battle.

We first examine the overall masculinity of the faces. In utero exposure to high testosterone levels has been shown to have strong effects on adult facial features, creating a "masculinizing" effect (Whitehouse et al., 2015). More masculine faces, in turn, are a predictor of aggression in men (Carré and McCormick, 2008), suggesting that the "cowardice problem" should have been less pronounced. Higher masculinity is correlated with more cooperative behavior in group competition settings, superior bargaining outcomes, and better financial performance in firms led by CEOs with more masculine faces (Stirrat and Perrett, 2012; Wong et al., 2011; Haselhuhn et al., 2014).

We train an LDA classifier for masculinity,[24] using landmarks from 3,500 historical portrait paintings from the WikiArt collection (1700–1850). For normalization, we center the landmarks at the eye midpoint, scale the size of the face by inter-eye distance and rotate so the eyes are level. The model then "learns" what distinguishes men from women. Men with features closer to the male than female spectrum are considered more "masculine." The naval officer portrait landmarks are then normalized in the same way and scored with this newly-trained LDA.

In addition, we train models of perceived personality traits in the spirit of Todorov (2017). We use the Chicago Face Database (CFD), which contains 822 frontal, neutral-expression photographs of individuals together with ratings of perceived facial traits such as dominance, threat, trustworthiness, happiness, and babyfacedness (Ma et al., 2015). For each face, we extract the normalized facial landmarks of the original. We classify faces into high- and low-scoring (top/bottom third) groups based on the CFD human ratings and train an LDA classification model on the landmark coordinates. Table A8 presents the training metrics for the trained models.

Figure A8 gives one illustration of the scores derived. The two officers in question have distinctly different careers. The one on the left, Sir Thomas Ussher, scores high on

[24] The approach follows Whitehouse et al. (2015).

masculinity, dominance, and approachability, but low on threath. He can claim six non-fleet victories over enemy ships. The one on the right, Philipp Affleck, scored no victories–despite commanding seven different ships in his career, including during seven years of war. Affleck only has a masculinity score of 0.22 (vs 0.97 for Ussher), and is scored as less dominant, less approachable, and more threatening than Ussher. Our model gives a higher success probability to Ussher than to Affleck.

When we apply our classifiers to the entire set of officers in our sample, scores differ systematically between unsuccessful and successful officers. Figure 11 shows box-and-whiskers plots for successful and unsuccessful officers. Successful officers have significantly more masculine faces than unsuccessful ones.

[Figure 11 here]

The perceived trait models provide scores for each officer. Table 8 presents regression results of victories regressed on masculinity, "dominant" and "threatening" personality traits plus an approachability composite, constructed using the portraits' scores for perceived "trustworthiness", "happiness" and "babyfacedness".

[Table 8 here]

Masculinity predicts success (col. 1). Dominance is similarly associated with more victories (col. 2). The threatening personality trait is not statistically significant and has a negative sign (col. 3). Approachability shows a positive association (col. 4). In column (5), we use all variables simultaneously. All coefficients are significant, and have the expected sign. This suggests that a dominant, commanding personality may have a positive effect on success as long as dominance become threatening.

How good is the predictive power of these interpretable facial features for success? Consistent with the victory regressions, successful captains have higher fitted values on average. This reflects their higher masculinity, dominance, and approachability, as well as their lower perceived threat (Figure 12).

[Figure 12 here]

These results are robust to alternative measurement and analysis choices. Table A10 shows that the pattern remains significant, and if anything becomes more pronounced, when portrait scores are averaged at the captain level rather than analyzed at the portrait

level. The results are also unchanged when we use either raw non-fleet victories (panel A) or the log transform of victories (panel B), as shown in Table A11.

Finally, we can use dummies for the decade when a portrait was painted, to account for differences in artistic style. In Table A12, we also control for age at painting. Portraits painted after the death of the officer are excluded (as they cannot be copying from a living person). The resulting pattern of coefficients is very similar to the one for the full sample.

6.4 Facial Features and Sons of Service

Can facial features and inherited traits explain the success of sons of service? There is general agreement that facial characteristics have high heritability (Richmond et al., 2018); this is particularly true of sexual dimorphism (Mitchem et al., 2014). Figure A6 examines the similarity of facial measures derived from the portraits of father-son pairs on the one hand, and of random pairs of officers on the other. Father-son pairs show substantial similarity. Random pairs show the lowest similarity (greatest cosine distance).[25] The high degree of facial similarity between fathers and sons in our sample is consistent with a biological channel for the transmission of naval talent.[26]

We first show that portraits of sons of service display facial features associated with naval success. To that end, we retrain our random forest model predicting success, excluding sons of service from the training sample.[27] We then use the classifier to compare success probability scores for the sons of service (who are out of sample) with the scores for known "winners" and "failures". Figure 14 shows the classifier models' probability of success classification per portrait and group. Sons of service score significantly higher than failure captains. They also are also, on average, closer to the predicted success probability of the successful group than to the failure group. This shows that the facial traits that sons of service carry are also those that the trained prediction model picked up to estimate success probability.

[Figure 14 here]

We can also use a model-free measure of similarity to show that sons of service look more like "winners" or "failures". Using standard similarity comparison techniques based

[25] Table A13 reports the corresponding statistics and confirms that facial similarity of father-son pairs is greater than that of randomly matched individuals.

[26] If we cluster facial features for failures, successful captains, and sons of service, the sons of service cluster is markedly closer to the success group (Figure A9.

[27] This results in a slightly lower AUC of 0.563, partly because of fewer observations.

on convolutional neural networks (CNNs), we show that the faces of sons of service are more similar to the successful captains than to the failure group. In the right-hand panel of Figure 13, we plot the similarity score (cosine similarity) of each of our 155 sons of service with (i) the success group on the x-axis and (ii) with the failure group.[28] The 45 degree line would indicate equal measures of similarity. In 83% of cases, the sons of service are more similar to the success group than the failure group.

[Figure 13 here]

Can the greater predicted success for sons of service be traced back to interpretable facial features? Their masculinity score is indistinguishable from the success group of captains, but significantly different from the unsuccessful group (Figure 11). The same patterns holds for the other interpretable features derived from the Chicage Face Database as in the general sample. Sons of service score at an intermediate level, between success and failure, on all counts (dominance, threat, approachability, Table A9), but significance is not high.

To sum up, facial characteristics predict naval success; and sons of service share the facial features of successful officers, as well as those of their fathers. This suggests one plausible interpretation of our main finding that sons of service outperform non-legacies in part because of transmitted traits. One of these traits is an indirect indicator of aggression and courage in battle; the other is a set of related traits that make them look like better leaders.

7 Conclusion

Can the intergenerational transmission of skills account for the persistence of occupational dynasties? Or does the persistence of occupational dynasties reflect nepotism? Answering this question empirically is difficult due to the lack of data on the actual performance of parents and their offspring on the job, as well as data on their selection into professions.

We exploit unique data on the fighting record of 18th century Royal Navy captains. In numerous cases, sons followed in their fathers' footsteps, choosing a naval career when their father had commanded Royal Navy ships. Capturing and sinking enemy vessels in

[28] We use the Facenet512 model, which has the highest accuracy score in leaderboard competitions https://github.com/serengil/deepface. We identify the highest-quality (sharpness + contrast) portrait for each 155 sons of service and compare them with all 303 officers in the success and failure groups.

wartime was the single most important objective for navy captains, recognized by promotion, medals, and fame. Sons of service captured more than twice as many ships over the course of their careers than non-legacies. To avoid bias from the differential assignment by legacy status, we adjust for differences in equipment, task, and fighting environment. Even after these adjustments, sons of service outperformed non-legacy captains by a large margin, of 30-45%. When we further focus on chance settings where there was no scope for favorable task assignments and we directly observe the fighting strength of both British and enemy vessels, sons of service continue to outperform – winning more victories than non-legacies for any ratio of relative force.

We also show that sons of service were more positively selected; offspring of naval officers entered the service at high rates, and were promoted earlier and at higher frequency. The more distinguished and successful the father's navy career, the more likely his sons were to join the senior service. We argue that intergenerational skill transmission is an important driver of these results. Non-cognitive skills like risk aversion are often transmitted from parents to children. While we cannot measure skills directly in this historical setting, we combine a newly collected dataset of portrait paintings of naval officers with vision machine learning methods. This allows us to extract facial characteristics based on landmark identification. Successful navy officers have facial features that differ significantly from those of unsuccessful ones. In particular, successful officers have more masculine faces, a feature correlated with testosterone levels in utero and later in life. It is also strongly correlated risk-seeking and competitive behavior in team sports. Sons of service also have facial features that are correlated with *perceptions* of being more approachable, more dominant, and less threatening than unsuccessful captains. Overall, sons of service are more likely to look like successful officers, resembling their fathers and thus providing a plausible channel of vertical transmission.

We can rule out *direct* cultural transmission because sons of captains entering the navy almost never saw their fathers – for the modal child, he would have been away 9 years out of 10 during the first decade of their life.[29] Our results imply that occupational dynasties do not necessarily reflect nepotism; instead, they are more likely to be driven by inherited skills. Our findings suggest that a biological channel – direct heritability of skills – may be one of the reasons why sons of naval officers outperform non-legacies on objective performance measures. Intergenerational transmission of skills can lead to correlated performance, offering a new perspective on the persistence of occupational dynasties.

[29] We cannot rule out indirect effects of the extended family, or via the wives chosen by captains.

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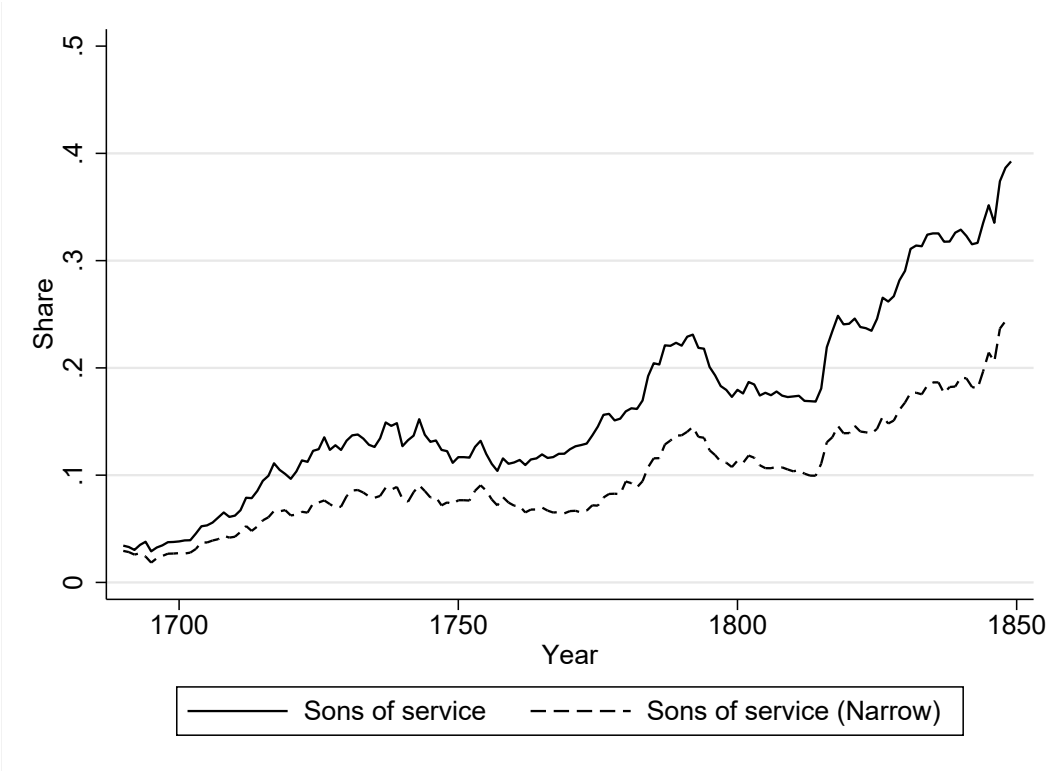
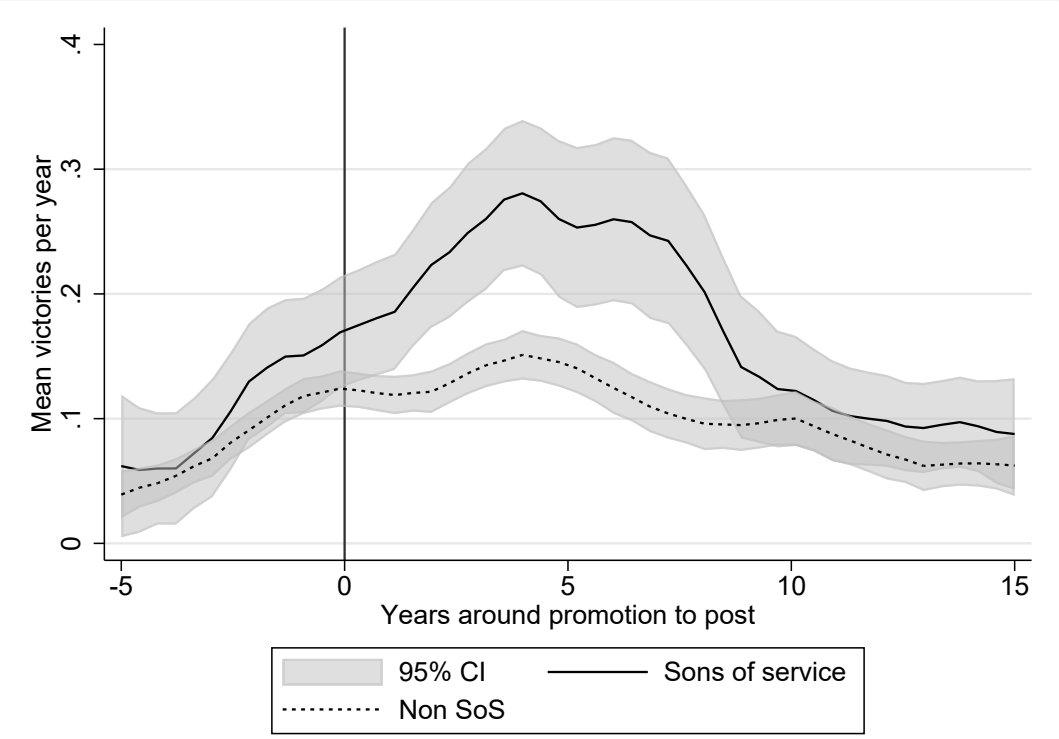
Figures and Tables

Figure 1: Sons of service among naval officers



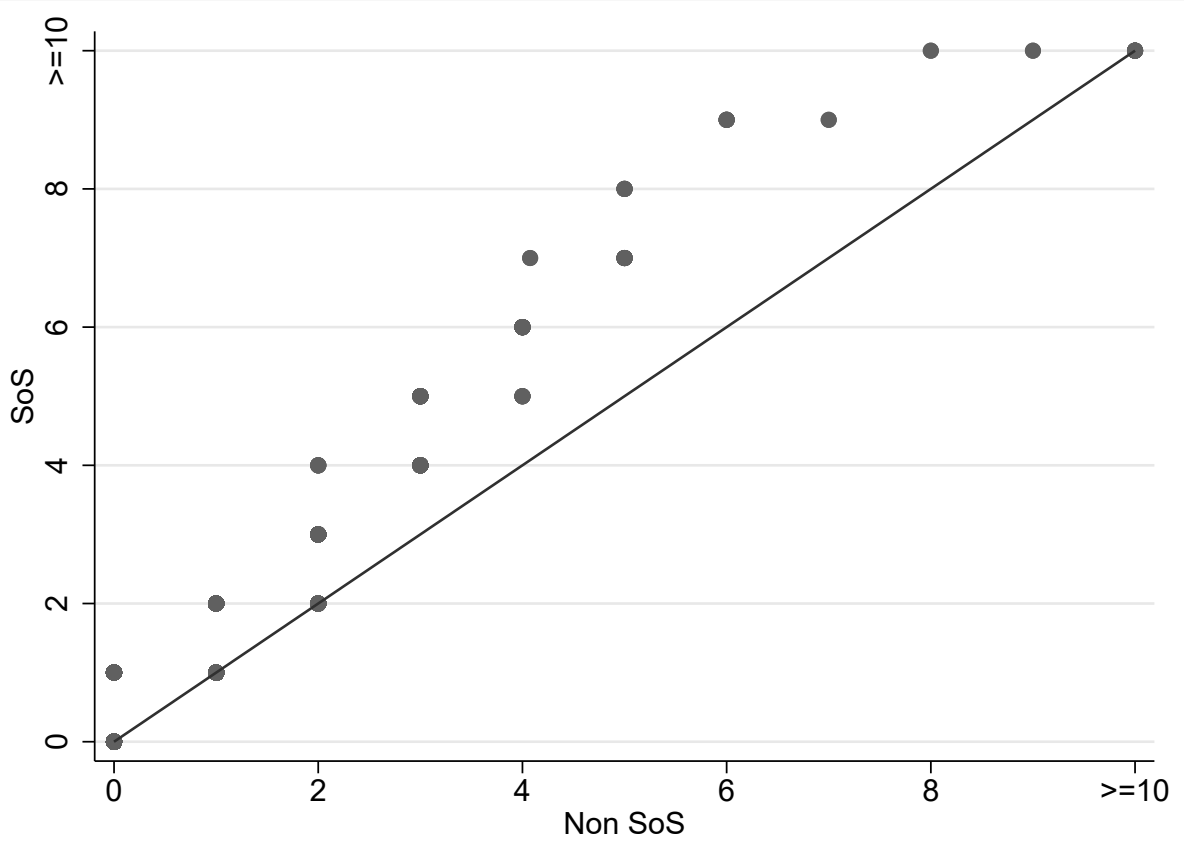
Notes: Figure shows the share of naval officers who are sons of service (defined as being the son, grandson, or nephew of a naval officer) over time. Sons of service (Narrow) is defined as being the son of a naval officer.

Figure 2: Capture performance for sons of service (SoS) vs. non-SoS



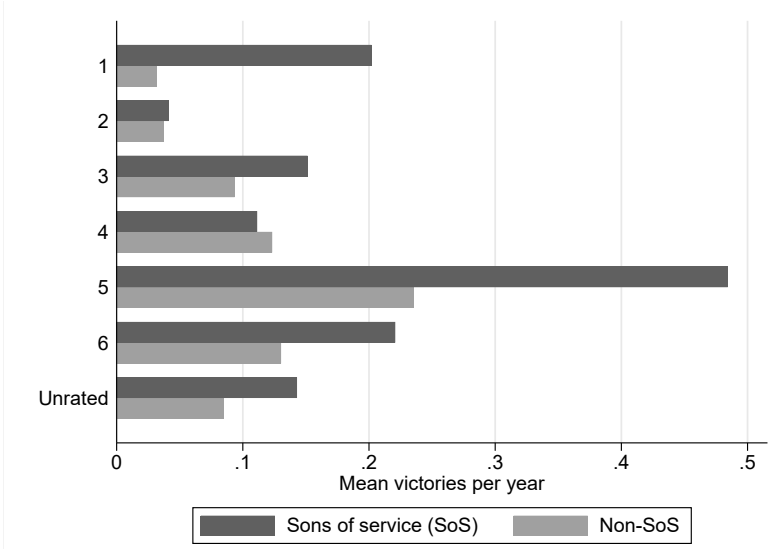
Notes: The figure shows the average yearly capture rate for non-legacy officers and for sons of the service. The black solid line is for sons of service; the grey dashed line, for other officers.

Figure 3: Quantile-quantile plot – performance of sons of service (SoS) vs. non-SoS

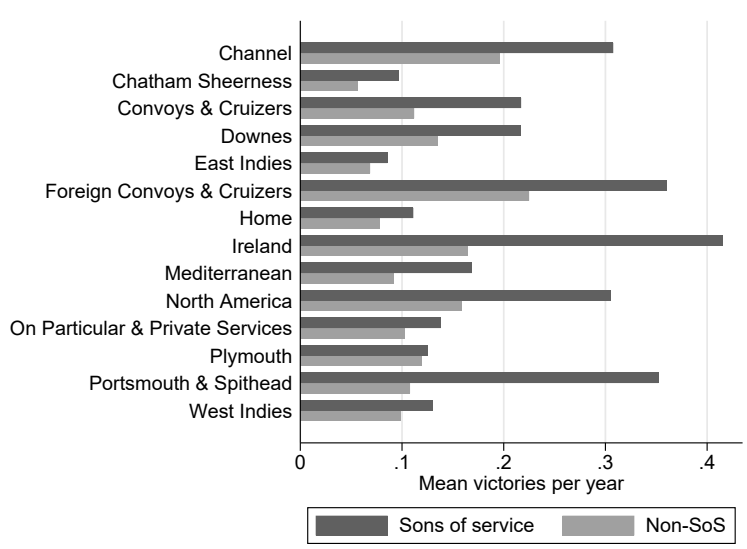


Notes: The figure shows a quantile-quantile plot of captures by sons of the service vs. other officers, ranking the performance of each group from lowest to highest. Performance is the mean number of captures and enemy ship sinkings per year. Observations are ordered from lowest (left-most) to highest (right-most). Random tie-breaking is applied. For any given percentile of "other officer" performance, sons of service score above the diagonal – meaning they outperform. The distance between the 45° degree line and the blue dots indicates the overall degree of outperformance.

Figure 4: Performance for sons of service (SoS) vs. non-SoS



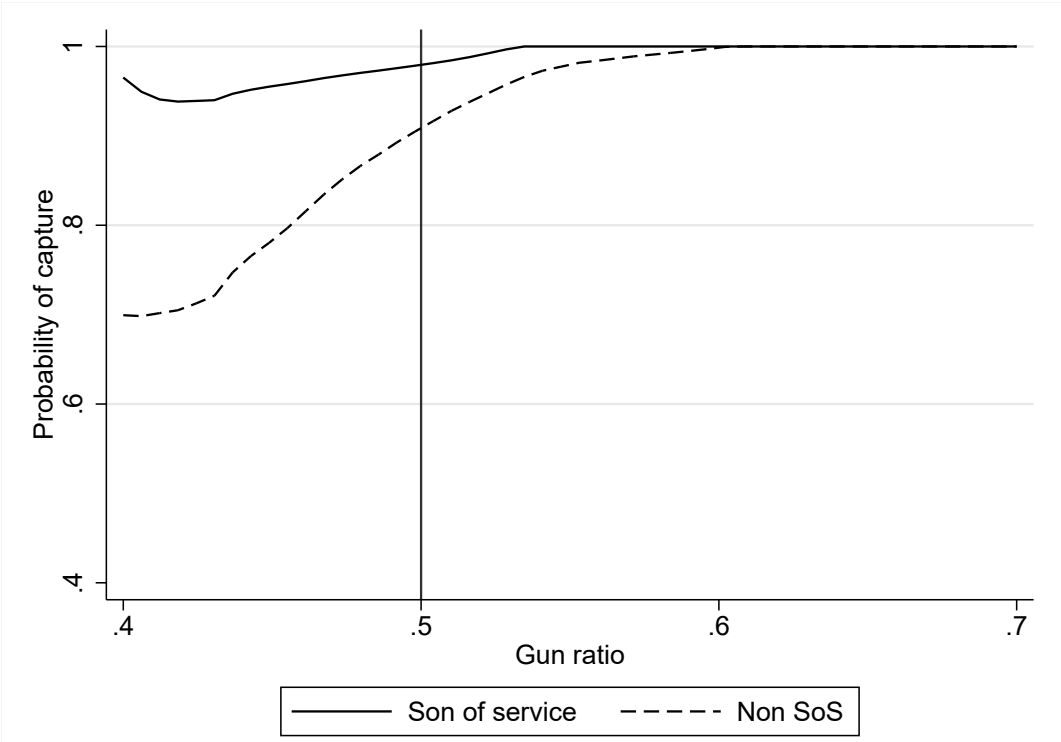
(a) By ship rate (class)



(b) By station/task

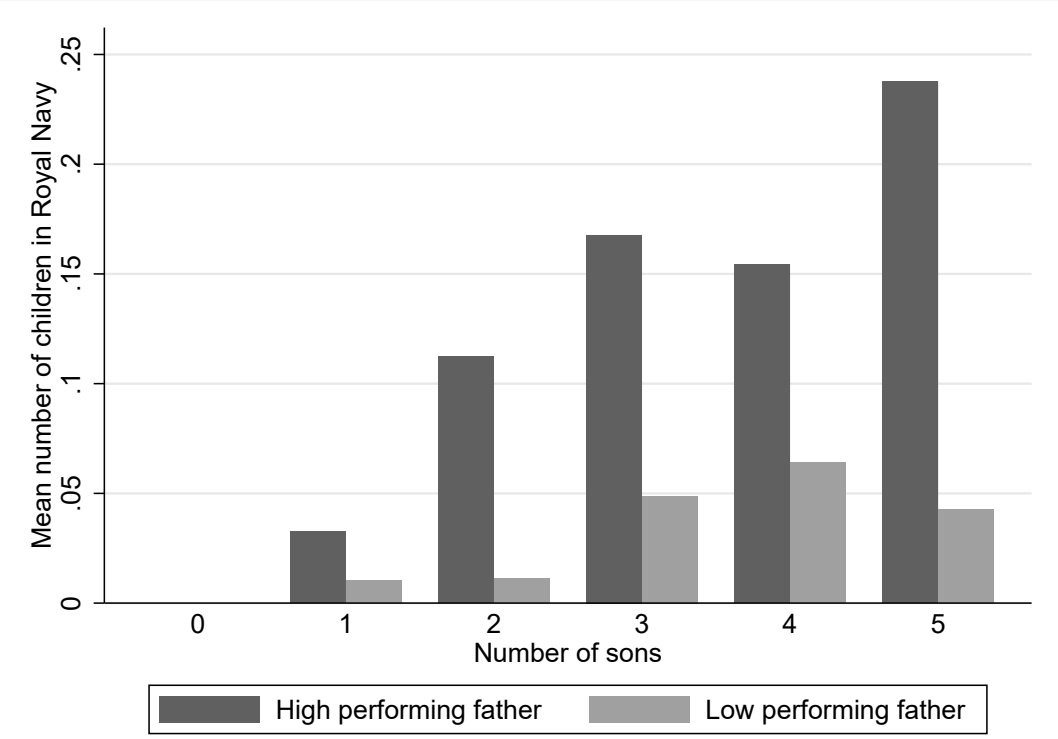
Notes: Figure shows the average performance (as measured by the number of captures and enemy ship sinkings) per year by whether the officer is a son of service (is the son, grandson, or nephew of a naval officer) or not (non-SoS). Panel (a) shows the mean victory rates per year for the rating (class) of the assigned ship, where 1st rate comprises the largest ships, and unrated the smallest. The median gun count for 1st and 2nd rate ships is 90, and the median gun count for unrated ships is 16. Panel (b) shows the mean victory rates per year for each station.

Figure 5: Probability of success in enemy captures: sons of service vs. non-SoS



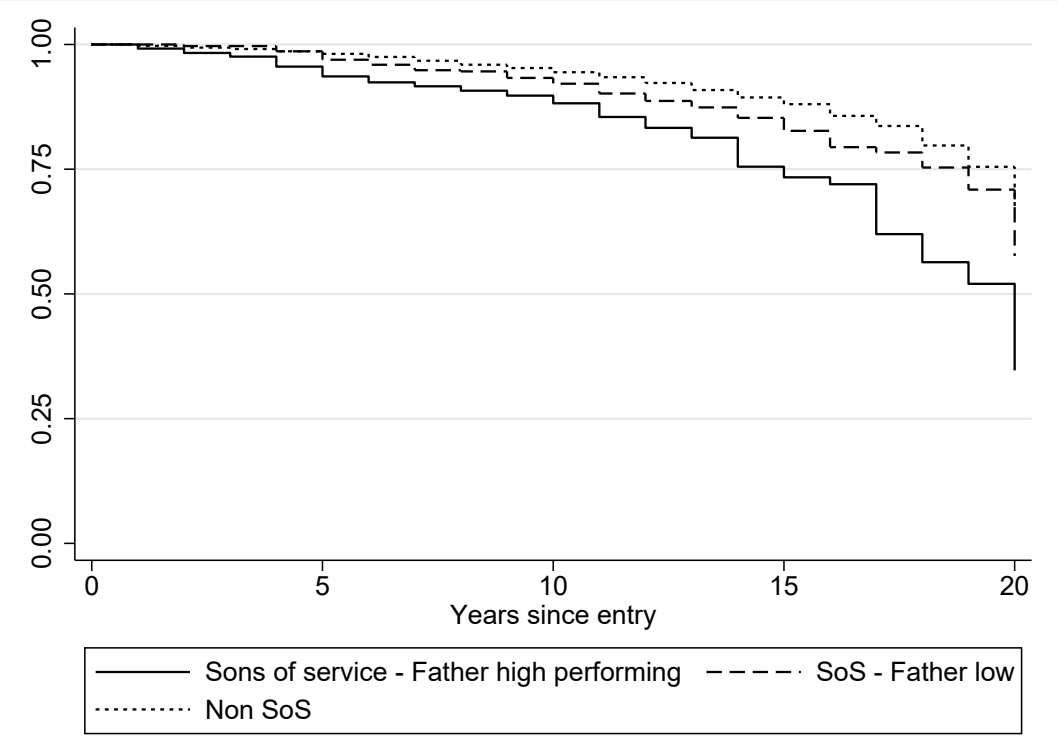
Notes: Figure shows the probability of a successful capture for the British ship as a function of the relative fighting strength. Fighting strength is measured by the gun ratio, defined as Gun ratio $= \text{Guns}_B/(\text{Guns}_B + \text{Guns}_E)$, where the subscript B denotes British and the subscript E denotes enemy guns. A gunshare of 0.5 indicates a duel between evenly matched battle ships. Results are broken down by sons of service (solid line) vs. non-SoS officers (dashed line).

Figure 6: Selection into the navy and father performance



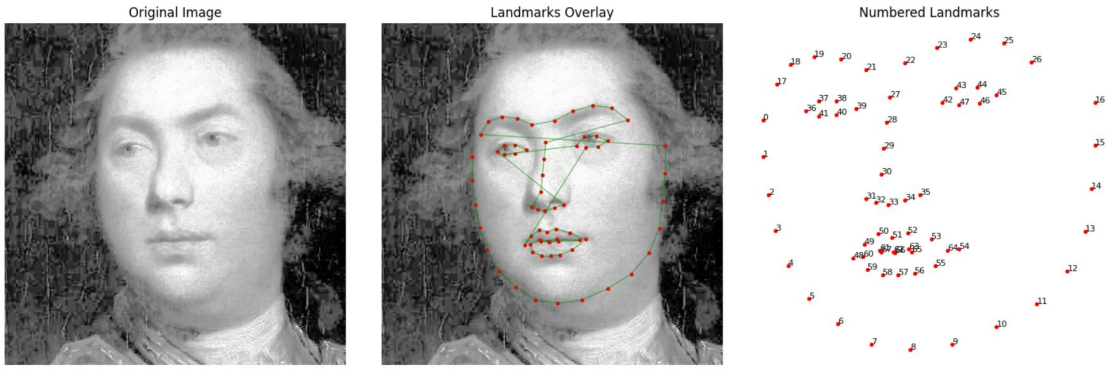
Notes: Figure shows the mean number of children joining the navy as a function of an officer's number of sons, broken down by whether the father is a high or low performing father. High performing father is defined as an officer who was either promoted to post or captured an above median number of enemy vessels.

Figure 7: Promotion to post for sons of service (SoS) vs. non-SoS



Notes: Figure shows the survival curves broken down by officers who are sons of service (defined as being the son, grandson, or nephew of a naval officer) and non-SoS over time. Sons of service are broken down by whether the father is high or low performing. High performing father is defined as an officer who was either promoted to post or captured an above median number of enemy vessels.

Figure 8: Sample portrait and extracted facial landmarks



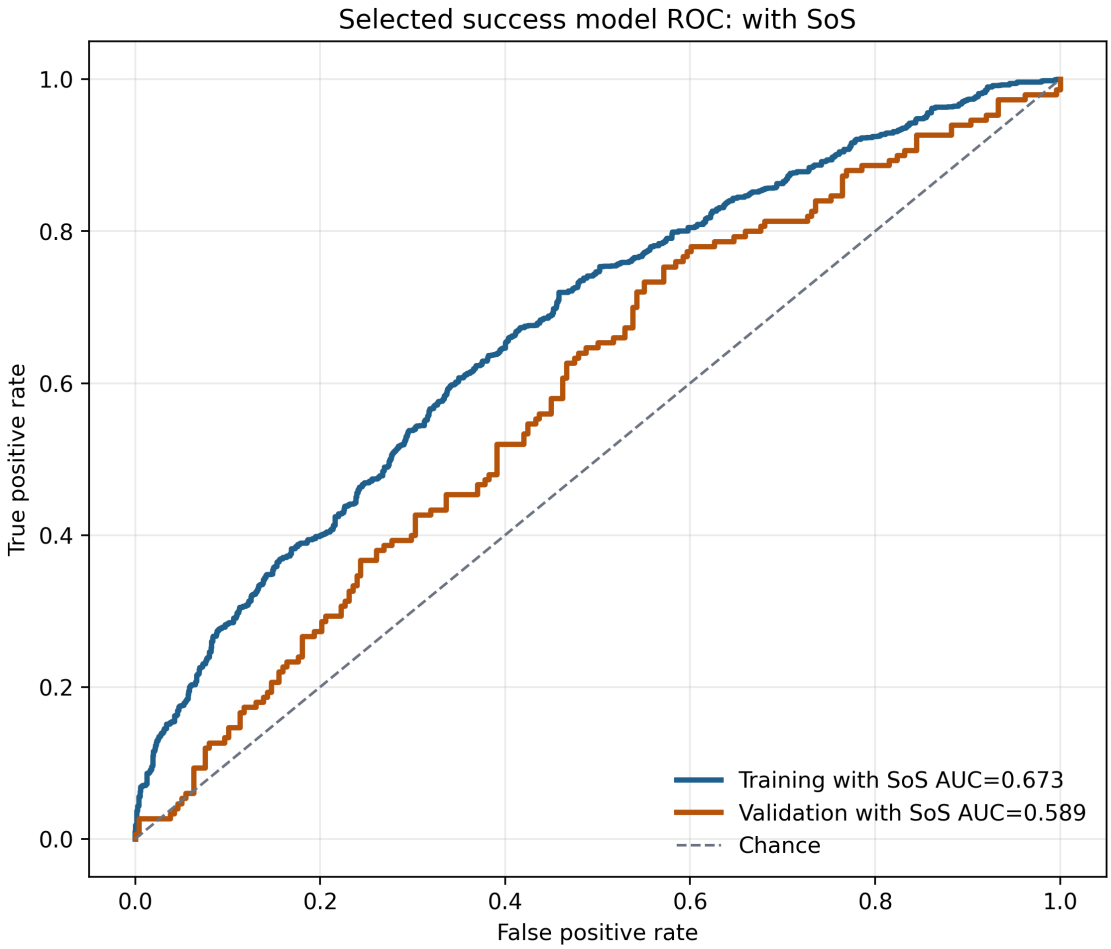
Notes: The figure shows an example of how facial landmarks are extracted from a cropped portrait of a naval officer (Thomas Harrison, serving in the Royal Navy between 1747–1766). We extract 68 facial landmarks from each image resulting in 136 facial landmark coordinates.

Figure 9: Portraits of successful and unsuccessful naval officers



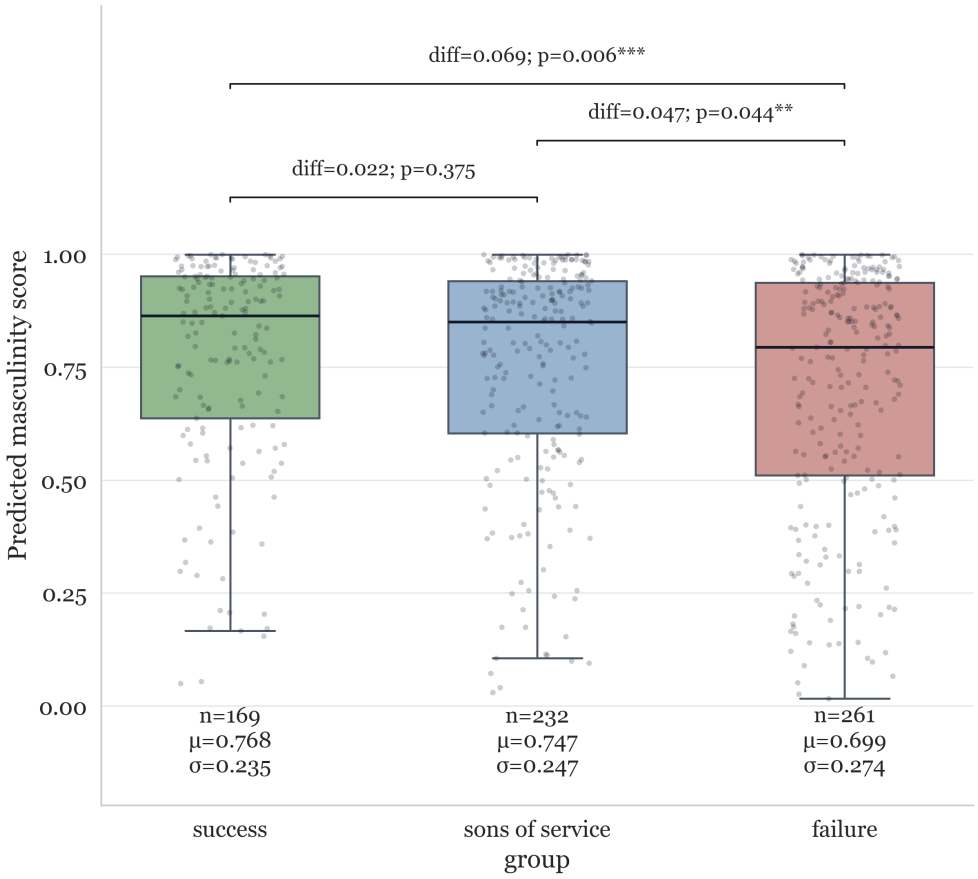
Notes: The figure shows example portraits of unsuccessful (upper panel) and successful (lower panel) naval officers. Successful officers are defined as those who have captured, sunk, or destroyed 4 or more enemy vessels; unsuccessful ones are those who have never captured, sunk, or destroyed an enemy vessel.

Figure 10: Receiver-Operating-Characteristic (ROC) Curves- Success Prediction Model



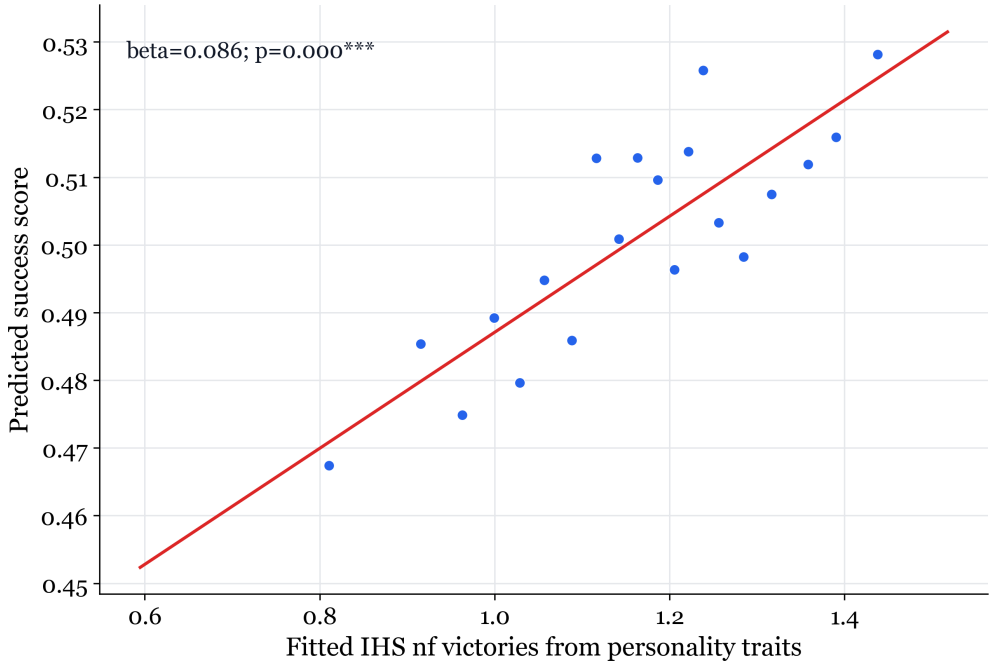
Notes: The figure shows receiver-operating-characteristic (ROC) curves for the 5-fold Cross Validation using an 80/20 training/validation sample. We predict the success of a naval officer (having 4 or more non-fleet victories) using a random forest estimator based on 8 Principal Components, derived from 39 facial geometries. Conditional on a given false positive rate, a higher true positive rate indicates higher performance. The area under curve (AUC) measures the integral of space between the 45 degree line and the performance curve, with 0.5 equivalent to random guesses and 1 indicating perfect prediction performance. We chose model hyperparameters optimising the Validation AUC while avoiding overfitting.

Figure 11: Masculinity scores – sons of service vs successful and unsuccessful captains



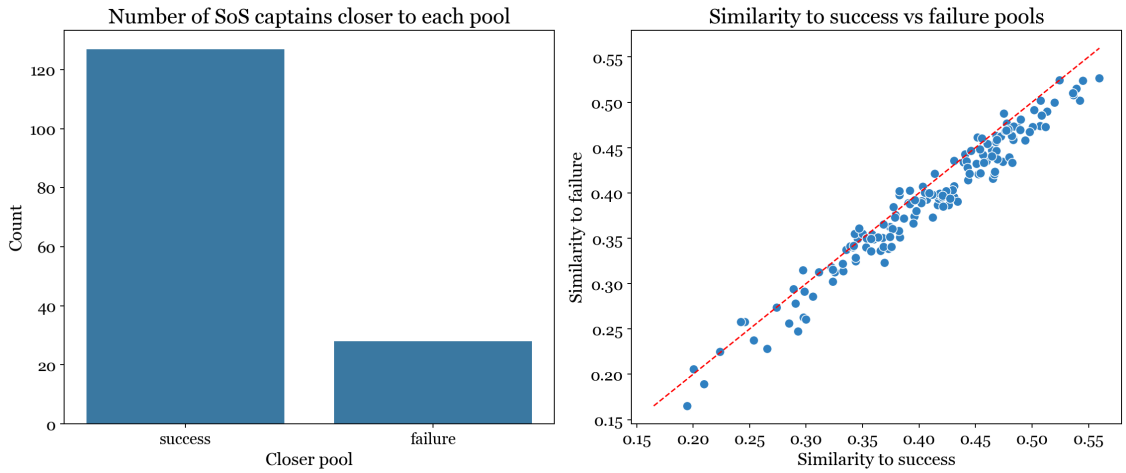
Notes: The figure shows box-and-whisper plots for the masculinity scores of portraits in three groups: success, failure and son of service. Scores are probabilities and, thus, between 0 and 1. Failure captains with no chance of scoring (no years of war in their career). The figure reports p-values for mean differences between the displayed groups; $*$, $**$, and $***$ indicate significance at the 10, 5, and 1 percent levels, respectively.

Figure 12: Success group probability and fitted IHS victories



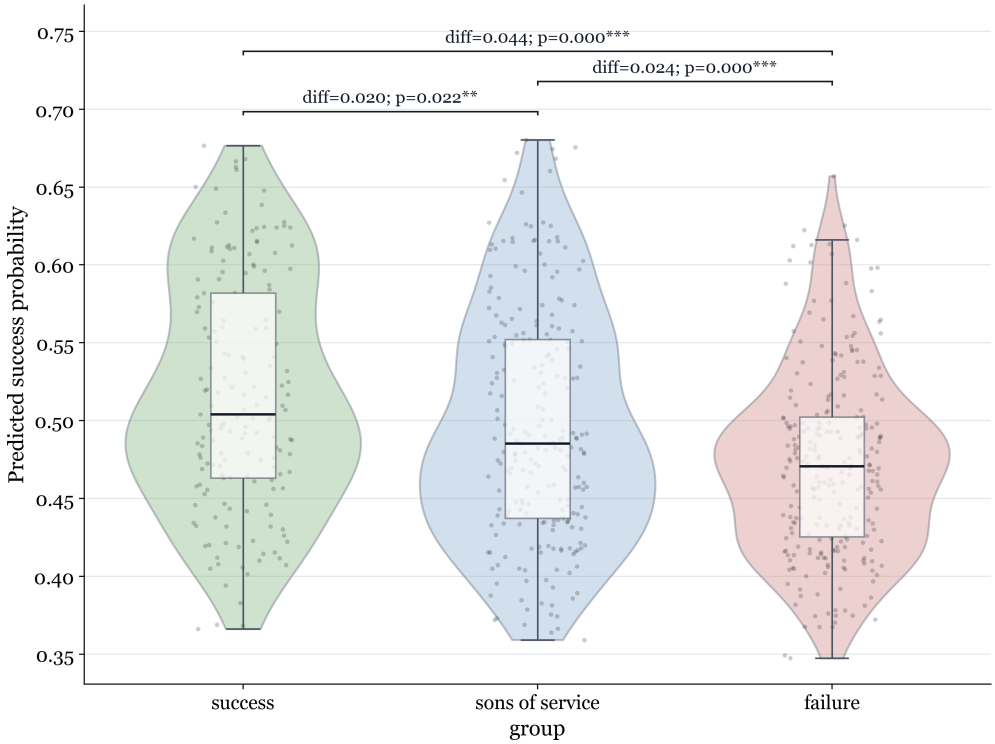
Notes: This portrait-level binscatter plots predicted success scores against fitted values from a regression of IHS non-fleet victories on personality traits. The figure uses 857 portraits from 553 captains, excluding those who did not see a year of war when commanding a ship. P-value is calculated using standard errors clustered on captain level.

Figure 13: Facial similarity of sons-of-service vs successful and unsuccessful captains



Notes: The left panel shows the frequency with which sons of service are more similar to the success or the failure group, based on facial similarity scores derived from the FaceNet512 model. The right panel plots the similarity of sons of service to the success group (x-axis) against their similarity to the failure group (y-axis). If both similarities were identical, points would lie on the 45-degree diagonal. Points below that line indicate portraits that are more similar to the success group than to the failure group, while points above it indicate the reverse. Successful officers are defined as those with four non-fleet victories or more, while unsuccessful officers are those classified with no victories in their lifetime.

Figure 14: Success prediction scores – sons of service vs successful and unsuccessful captains



Notes: The figure shows a raincloud plot of the predicted success group probability for three groups of officers – sons of service, successful officers, and unsuccessful ones ("failure"). Dots show individual portrait probablities to be of a successful or unsuccessful officer, calculated by the success prediction model trained **excluding sons of service**. Successful officers are defined as those who have captured or destroyed four or more enemy vessels in non-fleet battles; unsuccessful ones are those who have never captured, sunk, or destroyed an enemy vessel in a non-fleet battle even though they have commanded ships during times of war. Sons of service are always classified as sons of service, regardless of their naval success. The figure reports the p-values for the mean differences between each of the groups. *, **, *** indicate significance at the 1, 5, and 10% level. The success prediction model is a Random Forest estimator trained on 8 Principal Components based on 39 facial geometry measures, with an 80-20 train/validation split.

Table 1: Descriptive statistics

	(1) Mean	(2) SD	(3) IQR	(4) Obs.
Sons of service	0.093	0.291	0	5,848
Sons of service (Narrow)	0.057	0.233	0	5,848
Years of service	18.46	13.64	17	5,848
Total years commanding ship	6.34	5.02	7	5,848
Number of ships commanded	3.79	3.29	4	5,848
Ship of the line	0.228	0.34	0.42	5,848
Guns	32.14	20.69	33.47	5,808
Enemy ships captured	0.56	1.50	0	5,848
Enemy ships sunk	0.02	0.20	0	5,848
Victories (capture + sunk)	0.58	1.54	0	5,848
Made post	0.53	0.49	1	5,848
Made admiral	0.03	0.17	0	5,848

Notes: Unit of observation is a naval officer (i.e., all lieutenants, commanders, post-captains, and admirals). The sample includes all the naval officers who served during our study period of 1690–1849. Guns is the number of guns on ships commanded by the officer. We report the mean (column 1), standard deviation (column 2), interquartile range (column 3), and the total number of officers (column 4). Made post means promotion to post-captain, a permanent rise in seniority qualifying for command of major warships. A "ship of the line" is a large naval warship, typically with three gun decks and 70 or more cannons (ship rated 1–4).

Table 2: Performance for sons of service vs. non-SoS

	(1)	(2)	(3)	(4)	(5)
			Victories		
Mean of dep. var	0.133	0.133	0.133	0.169	0.176
Sons of service	0.113***	0.097***	0.071***	0.069***	0.072***
	(0.017)	(0.017)	(0.016)	(0.019)	(0.020)
Year FEs	✓	✓	✓	✓	✓
Tenure FEs	✓	✓	✓	✓	✓
Ship rate FEs		✓			
Ship FEs			✓		
Ship-crew FEs				✓	✓
Station FEs					✓
Observations	36,997	36,997	36,678	24,758	22,270

Notes: Unit of observation is the officer-year. Table compares victories of officers who are sons of service (i.e., those who are sons, grandsons, or nephews of naval officers) and those who are not. The sample is restricted to officers who are in command of a ship in a given year. Tenure is computed as years since entry into the navy. Ship rate FEs are dummies for each rate of the ship (1–6, unrated); ship FEs are fixed effects for each assigned ship; ship-crew are fixed effects for each ship and unique crew combination. Station FEs are fixed effects for each station (or task) the officer is assigned to. Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Sons of service performance around father's death

	(1)	(2)	(3)	(4)	(5)
		Post-promotion victories			
Mean of dep. var	0.194	0.235	0.235	0.235	0.233
Sons of service	0.089***	0.095***	0.114**		
	(0.023)	(0.035)	(0.054)		
Father dead		0.051	0.062	-0.044	
		(0.042)	(0.044)	(0.048)	
Sons of service × Father dead			-0.033	-0.030	-0.02498
			(0.070)	(0.079)	(0.12201)
Year FEs	✓	✓	✓	✓	✓
Tenure FEs	✓	✓	✓	✓	
Ship-crew FEs	✓	✓	✓	✓	✓
Station FEs	✓	✓	✓	✓	✓
Father birth & death year FEs		✓	✓	✓	
Year around father death FEs				✓	✓
Sons of service × Tenure FEs				✓	✓
Officer FEs					✓
Observations	16,989	7,880	7,880	7,871	8,052

Notes: Unit of observation is the officer-year. Table compares post-promotion victories of officers who are sons of service (i.e., those who are sons, grandsons, or nephews of naval officers) and those who are not. In all specification, the sample is restricted to officers who are in command of a ship. Father dead is a dummy that is 1 if the officer's father passed away and 0 otherwise. Similarly, Sons of service × Father dead is a dummy that is 1 if the father of a given SoS pased away and 0 otherwise. Fixed effects are defined as in Table 2; father birth & death year FEs are dummies for the father's birth cohort and year of death. Officer FEs are individual officer fixed effects. Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Father performance and selection into navy

	(1)	(2)	(3)	(4)	(5)
			Son in navy		
Mean of dep. var	0.0636	0.0636	0.0636	0.0636	0.0636
Father high performance	0.076***	0.063***	0.067***	0.051***	0.053***
	(0.012)	(0.014)	(0.011)	(0.011)	(0.011)
Sons of service				0.107***	0.138**
				(0.025)	(0.060)
Sons of service × Father high performance					-0.037
					(0.065)
Father performance (high=1, low=0)	Post	Capture	Both		
Entry year FEs	✓	✓	✓	✓	✓
Number of sons FEs	✓	✓	✓	✓	✓
Observations	2,060	2,060	2,060	2,060	2,060

Notes: Unit of observation is the officer. Table compares the likelihood of an officer's child to join the navy as a function of the father's performance. In column 1, high performance is defined as 1 if the father himself made post. In column 2, high performance is defined as 1 if the father captured or sank at least one enemy ship. In columns 3–5, high performance is 1 if the father either made post or captured / sank at least one enemy ship. Robust standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: Sons of service, father's performance and promotion to post

	(1)	(2)	(3)	(4)
		Promoted to post		
Mean of dep. var	0.0812	0.0812	0.0812	0.0812
Sons of service	0.046***			
	(0.010)			
Sons of service × Father high performance		0.053***	0.066***	0.060***
		(0.011)	(0.016)	(0.011)
Sons of service × Father low performance		0.003	0.028**	-0.017
		(0.016)	(0.011)	(0.014)
Father performance (high=1, low=0)	-	Post	Capture	Both
p-value: Father high - low performance	-	0.010**	0.046**	0.001***
Year FEs	✓	✓	✓	✓
Tenure FEs	✓	✓	✓	✓
Observations	31,613	31,613	31,613	31,613

Notes: Unit of observation is the officer-year. Table compares the promotion chances of sons of service (officer who is a son, grandson, or nephew of a naval officer) to those who are non-SoS. The sample is restricted to officers who can still be promoted (i.e., lieutenants and commanders). Columns 2–4 distinguish whether the father is a high or low performer. In column 2, high performance is defined as 1 if the father himself made post. In column 3, high performance is defined as 1 if the father captured or sank at least one enemy ship. In column 4, high performance is 1 if the father either made post or captured / sank at least one enemy ship. Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: Promotion of sons of service by whether father is alive or not

	(1)	(2)	(3)
	Promoted to post		
Mean of dep. var	0.0842	0.0829	0.0820
Sons of service × Father high performer	0.075***	0.075***	0.079***
	(0.014)	(0.024)	(0.017)
Sons of service × Father low performer	-0.020	0.017	-0.061***
	(0.017)	(0.027)	(0.021)
Sample	Full	Father died	Alive
p-value: Father high performance died-alive		0.899	
p-value: Father low performance died-alive		0.056*	
p-value: High=Low performance	0.000**	0.201	0.000***
Year FEs	✓	✓	✓
Tenure FEs	✓	✓	✓
Father birth & death year FEs	✓	✓	✓
Observations	12,947	12,121	12,411

Notes: Unit of observation is the officer-year. Table compares the promotion chances of sons of service (broken down by whether father was high or low performer) to those who are non-SoS. The sample is restricted to officers who can still be promoted (i.e., lieutenants and commanders). Column 1 reports the result based on the full sample. Column 2 restricts the sample to sons of service with dead fathers and non-SoS, and column 3 restricts the sample to sons of service with living fathers and non-SoS. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7: Sons of service performance for war-time vs. peace-time promotions

	(1)	(2)	(3)
	Promoted	Post-promotion victories	
Mean of dep. var	0.0831	0.241	0.143
War	0.012***		
	(0.003)		
Sons of service		0.120***	0.084***
		(0.037)	(0.025)
Sample	Pre-Promotion	Promotion during War	Promotion during Peace
Tenure FEs	✓	✓	✓
Linear time trend	✓		
Year FEs		✓	✓
Ship-crew FEs		✓	✓
Station FEs		✓	✓
p-value: Sons of service war-peace		0.414	
Observations	33,430	8,850	7,659

Notes: Unit of observation is the officer-year. Column 1 compares the promotion chances of officers during war vs. peace times. The sample is restricted to officers who can still be promoted (i.e., lieutenants and commanders). War is a dummy that is 1 if the total number of captures in the given year is above average. Columns 2-3 compare the post-promotion performance of sons of service (officer who is a son, grandson, or nephew of a naval officer) to those of non-SoS, broken down by whether the promotion to post occurred in a war year (column 2) or not (column 3). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: Portrait-level regressions of IHS non-fleet victories on facial traits

	(1)	(2)	(3)	(4)	(5)
		IHS(non-fleet victories)			
Mean of dep. var	1.159	1.159	1.159	1.159	1.159
Masculinity	0.108**				0.117***
	(0.042)				(0.042)
Dominance		0.073*			0.075*
		(0.038)			(0.039)
Threat			-0.057		-0.072*
			(0.038)		(0.039)
Approachability				0.055	0.071**
				(0.037)	(0.036)
Observations	857	857	857	857	857
Captains	553	553	553	553	553

Notes: Masculinity is the normalized historical masculinity-model score. CFD predictors are from the newly trained strict CFD top-versus-bottom-tertile models. CFD approachability is the mean of z-scored CFD trustworthy, happy, and babyfaced scores. The horse-race column includes all listed predictors jointly. Continuous predictors are z-scored; the Sons of Service dummy is unstandardized. Sons of Service with zero war-year command exposure are excluded because the outcome is victories. Standard errors, clustered by captain, are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

A Appendix - For Online Publication

A.1 Appendix Tables - For Online Publication

Table A1: Identifying sons of service

	(1)	(2)
	Sons of service	
	Preferred	Narrow
Threedecks	348	285
Ancestry	186	113
Peerage	184	57
Pooled	547	338

Notes: Summarizing the sons of service found by dataset. Column 1 lists the sons of service, defined as an officer with a father, uncle, or grandfather in the Royal Navy. Column 2 lists the sons of service defined as an officer with a father in the Royal Navy. Pooled reports the total number of unique individuals combined across all three data sources.

Table A2: Performance for sons of service vs. non-SoS – alternative definitions

	(1)	(2)	(3)	(4)	(5)
			Victories		
	Number	Any	Above 1	Above 2	PPML
Mean of dep. var	0.176	0.0923	0.0370	0.0165	0.410
Sons of service	0.072***	0.027***	0.018***	0.010***	0.295***
	(0.020)	(0.007)	(0.005)	(0.003)	(0.077)
Year FEs	✓	✓	✓	✓	✓
Tenure FEs	✓	✓	✓	✓	✓
Ship-crew FEs	✓	✓	✓	✓	✓
Station FEs	✓	✓	✓	✓	✓
Observations	22,270	22,270	22,270	22,270	9,526

Notes: Unit of observation is the officer-year. Table compares victories of officers who are sons of service (i.e., those who are sons, grandsons, or nephews of naval officers) and those who are not. The sample is restricted to officers who are in command of a ship in a given year. Tenure is computed as years since entry into the navy; ship-crew are fixed effects for each ship and unique crew combination. Station FEs are fixed effects for each station (or task) the officer is assigned to. Column 1 shows the baseline specification using the total number of victories in a year as the dependent variable; column 2 is a dummy that is 1 for any victories in a given year and 0 otherwise; columns 3 (column 4) is a dummy that is 1 if the number of victories exceed 1 (2) in a given year; column 5 uses the total number of victories in a year as the dependent variable, estimating the regression using Poisson Pseudo Maximum Likelihood (PPML). Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3: Gun ratios and captures for individual ship encounters

	(1)	(2)	(3)
		Victory	
Mean of dep. var	0.976	0.976	0.977
Sons of service	0.022***	0.018***	0.018**
	(0.007)	(0.007)	(0.008)
Gun ratio		0.360***	0.318***
		(0.063)	(0.057)
Commanding	✓	✓	✓
Year FEs			✓
Tenure FEs			✓
Observations	1,383	1,383	1,365

Notes: Unit of observation is a ship capture event. Comparing the win rate of sons of service with the win rate of non-legacies. The sample is restricted to officers who have made post. Victory is a dummy that is 1 if the British officer captured the enemy ship and 0 if the officer's ship was captured. Sons of service is defined as an officer who is the son, grandson, or nephew of a navy officer. Gun ratio is the defined as the number of own guns/(number of own guns+number of enemy guns). Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: Sons of service performance vs. sons of MPs

	(1)	(2)	(3)
	Victories		
Mean of dep. var	0.176	0.176	0.176
Sons of service	0.072***		0.071***
	(0.020)		(0.020)
Sons of MP		0.006	0.001
		(0.021)	(0.021)
Year FEs	✓	✓	✓
Tenure FEs	✓	✓	✓
Ship-crew FEs	✓	✓	✓
Station FEs	✓	✓	✓
p-value: SoS - SoMPs			0.025**
Observations	22,270	22,270	22,270

Notes: Unit of observation is the officer-year. Table compares victories of officers who are sons of service, sons of MPs and those who are not, broken down by pre-promotion performance (Panel A) and post-promotion performance (Panel B). In all specification, the sample is restricted to officers who are in command of a ship. Sons of service is defined as an officer who is the son, grandson, or nephew of a navy officer. Sons of MP is defined as an officer who is the son of an MP. Tenure is computed as years since entry into the navy. Fixed effects defined as in Table 2. Standard errors (in parentheses) are clustered at the officer level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5: Father performance and selection into navy – sons of MPs

	(1)	(2)	(3)	(4)
	Son in navy			
Mean of dep. var	0.0636	0.0636	0.0636	0.0636
Father high performance	0.067***	0.051***	0.067***	0.051***
	(0.011)	(0.011)	(0.011)	(0.011)
Sons of service		0.107***		0.107***
		(0.025)		(0.025)
Sons of MPs			-0.013	-0.018
			(0.022)	(0.022)
Entry year FEs	✓	✓	✓	✓
Number of sons FEs	✓	✓	✓	✓
Observations	2,060	2,060	2,060	2,060

Notes: Unit of observation is the officer-year. Table compares the promotion chances of sons of service and sons of MPs (broken down by whether father was high or low performer) to those who are non-SoS/MPs. The sample is restricted to officers who can still be promoted (i.e., lieutenants and commanders). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6: Descriptive statistics - officers with and without current audited portraits

	(1)	(2)	(3)	(4)
	Mean of characteristic (row)			Diff.
	Pooled	Portrait	No portrait	(2)-(3)
Sons of service	0.094	0.261	0.071	0.190***
				(0.017)
Sons of service (Narrow)	0.058	0.137	0.047	0.090***
				(0.013)
Years of service	18.460	31.189	16.773	14.416***
				(0.618)
Total years commanding ship	6.339	10.756	5.753	5.003***
				(0.235)
Number of ships commanded	3.793	7.277	3.331	3.946***
				(0.173)
Ship of the line	0.229	0.379	0.209	0.170***
				(0.013)
Guns	32.149	44.732	30.467	14.265***
				(0.763)
Enemy ships captured	0.803	2.441	0.586	1.855***
				(0.158)
Enemy ships sunk	0.069	0.238	0.047	0.191***
				(0.041)
Victories	0.873	2.679	0.633	2.046***
				(0.171)
Made post	0.527	0.882	0.480	0.402***
				(0.014)
Made admiral	0.027	0.109	0.016	0.093***
				(0.012)
Observations	5,848	685	5,163	
Final analysis captains		564		

Notes: Unit of observation is the naval officer. The pooled sample is the service-panel officer universe. The portrait indicator is defined from all current physical main-sample portraits before quality and war-year filters. The portrait roster contains 1,086 portrait rows for 698 captains; 688 of these captains link to the service panel and define column (2). Column (4) reports Welch two-sample differences in means, with standard errors in parentheses. The war-year regression restriction is not applied. Current capture, sinking, and victory totals use the rebuilt ship-level victory panel. Significance: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table A7: Portrait availability regressions by sons of service - current audited portraits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Officer has portrait				
Mean of dep. var	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176	0.1176
Sons of service	0.1352***	0.0403	0.0354	0.0165	-0.0173	0.1035***	0.1598***	-0.0789
	(0.026)	(0.038)	(0.040)	(0.033)	(0.046)	(0.028)	(0.025)	(0.051)
Victories	0.0383***							0.0221***
	(0.004)							(0.003)
Sons of service × Victories	-0.0070							-0.0083
	(0.008)							(0.008)
Years commanding		0.0192***						-0.0011
		(0.001)						(0.002)
Sons of service × Years commanding		0.0082*						0.0034
		(0.004)						(0.007)
Years of service			0.0075***					0.0029***
			(0.000)					(0.000)
Sons of service × Years of service			0.0028*					0.0002
			(0.002)					(0.002)
Number of ships commanded				0.0356***				0.0211***
				(0.002)				(0.003)
Sons of service × Number of ships commanded				0.0112**				0.0051
				(0.006)				(0.010)
Mean ship guns					0.0031***			0.0010***
					(0.000)			(0.000)
Sons of service × Mean ship guns					0.0041***			0.0028
					(0.001)			(0.002)
Share ship of line						0.1344***		-0.0521***
						(0.013)		(0.017)
Sons of service × Share ship of line						0.1628**		-0.0420
						(0.072)		(0.090)
Admiral							0.3637***	0.1286***
							(0.043)	(0.042)
Sons of service × Admiral							-0.1025	-0.1195
							(0.112)	(0.112)
p-value H0: all interactions = 0								0.286
Observations	5,848	5,848	5,848	5,848	5,848	5,848	5,848	5,848

Notes: Unit of observation is the naval officer. The dependent variable is an indicator for whether the officer appears in all current physical main-sample portraits before quality and war-year filters. Victories use the rebuilt ship-level victory panel collapsed to captain level. The war-year regression restriction is not applied. Heteroskedasticity-robust HC1 standard errors are reported in parentheses. Significance: *** p¡0.01, ** p¡0.05, * p¡0.10.

Table A8: Training performance of normalized CFD trait models

Trait	N	CV AUC	CV accuracy	CV recall	CV F1	Test AUC	Test accuracy	Test recall	Test F1
Dominant	407	0.810	0.750	0.770	0.750	0.728	0.659	0.625	0.641
Threatening	549	0.807	0.720	0.719	0.718	0.830	0.755	0.764	0.757
Trustworthy	549	0.792	0.723	0.724	0.724	0.822	0.745	0.764	0.750
Babyfaced	548	0.735	0.666	0.660	0.663	0.735	0.700	0.727	0.708
Happy	551	0.890	0.813	0.796	0.808	0.898	0.811	0.818	0.811

Table A9: Personality trait means by group

	Masculinity	Dominance	Threat	Approachability
Panel A: Success				
Mean	0.768	0.647	0.392	0.041
95% CI	[0.727, 0.809]	[0.579, 0.715]	[0.326, 0.459]	[-0.038, 0.120]
Portraits	169	169	169	169
Captains	101	101	101	101
Panel B: Sons of service				
Mean	0.747	0.638	0.413	-0.018
95% CI	[0.710, 0.783]	[0.578, 0.697]	[0.355, 0.472]	[-0.092, 0.056]
Portraits	232	232	232	232
Captains	155	155	155	155
Panel C: Failure				
Mean	0.699	0.599	0.432	-0.025
95% CI	[0.663, 0.736]	[0.546, 0.653]	[0.379, 0.484]	[-0.100, 0.049]
Portraits	261	261	261	261
Captains	177	177	177	177

Notes: Means are computed on portrait-level observations. Confidence intervals use standard errors clustered by captain. Masculinity is the normalized masculinity score; dominance, threat, and approachability are CFD-based trait scores.

Table A10: Robustness check: Captain mean trait regressions for IHS non-fleet Victories

	IHS(non-fleet victories)				
	(1)	(2)	(3)	(4)	(5)
Mean of dep. var	1.113	1.113	1.113	1.113	1.113
Masculinity	0.094**				0.101**
	(0.044)				(0.045)
Dominance		0.106**			0.111**
		(0.047)			(0.048)
Threat			-0.081*		-0.092**
			(0.046)		(0.046)
Approachability				0.082*	0.093**
				(0.044)	(0.044)
Observations	553	553	553	553	553
Captains	553	553	553	553	553

Notes: Each non-horse-race column is a separate univariate regression. The horse-race column includes the four listed personality-trait predictors jointly. Continuous predictors are z-scored. This table shows that the presented results do not only hold on portrait level, but also do and even strengthen, if one would mean the personality trait predicted scores on captain level. Standard errors are HC3 and shown in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A11: Robustness check: Portrait-level trait regressions under alternative non-fleet victory transformations

	Panel A: Raw non-fleet victories					Panel B: log(1 + non-fleet victories)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean of dep. var	2.739	2.739	2.739	2.739	2.739	0.906	0.906	0.906	0.906	0.906
Masculinity	0.318**				0.352**	0.085**				0.093***
	(0.152)				(0.148)	(0.034)				(0.033)
Dominance		0.200			0.208		0.057*			0.059*
		(0.126)			(0.133)		(0.030)			(0.031)
Threat			-0.175		-0.214*			-0.045		-0.057*
			(0.127)		(0.127)			(0.030)		(0.031)
Approachability				0.192	0.238*				0.044	0.056**
				(0.129)	(0.123)				(0.029)	(0.028)
Observations	857	857	857	857	857	857	857	857	857	857
Captains	553	553	553	553	553	553	553	553	553	553

Notes: Continuous predictors are z-scored. Panel A reports regressions of raw non-fleet victories on perceived personality traits; Panel B of log(1 + non-fleet victories). The comparison shows that the main patterns are not specific to the IHS transformation. The raw-victory outcome is highly skewed and function as a robustness check on signs and relative stability. Standard errors are clustered by captain and shown in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A12: Robustness check: Portrait level regressions with age and painting-decade controls

	IHS non-fleet victories				
	(1)	(2)	(3)	(4)	(5)
Mean of dep. var	1.181	1.181	1.181	1.181	1.181
Masculinity	0.115**				0.117**
	(0.051)				(0.051)
CFD dominance		0.088**			0.082*
		(0.042)			(0.043)
CFD threat			-0.019		-0.037
			(0.043)		(0.044)
CFD approachability				0.051	0.071*
				(0.040)	(0.039)
Observations	714	714	714	714	714
Captains	476	476	476	476	476
Decade painted FE	✓	✓	✓	✓	✓
Age controls (age + age^2)	✓	✓	✓	✓	✓
Dropped post-death portraits	✓	✓	✓	✓	✓

Notes: Continuous trait predictors are z-scored. The sample is the portrait-level victory sample, excluding captains with no years of war during their command. The robustness specification includes 10-year painting-year fixed effects and continuous age plus age squared, and drops portraits painted after the captain's death or with implied age 80 or above, in cases where the date of death was not available. When dates of birth were not reported, they were imputed using the captain's date of promotions to lieutenant and commander. The resulting table uses 20 painting-year cells. Standard errors are clustered by captain and shown in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

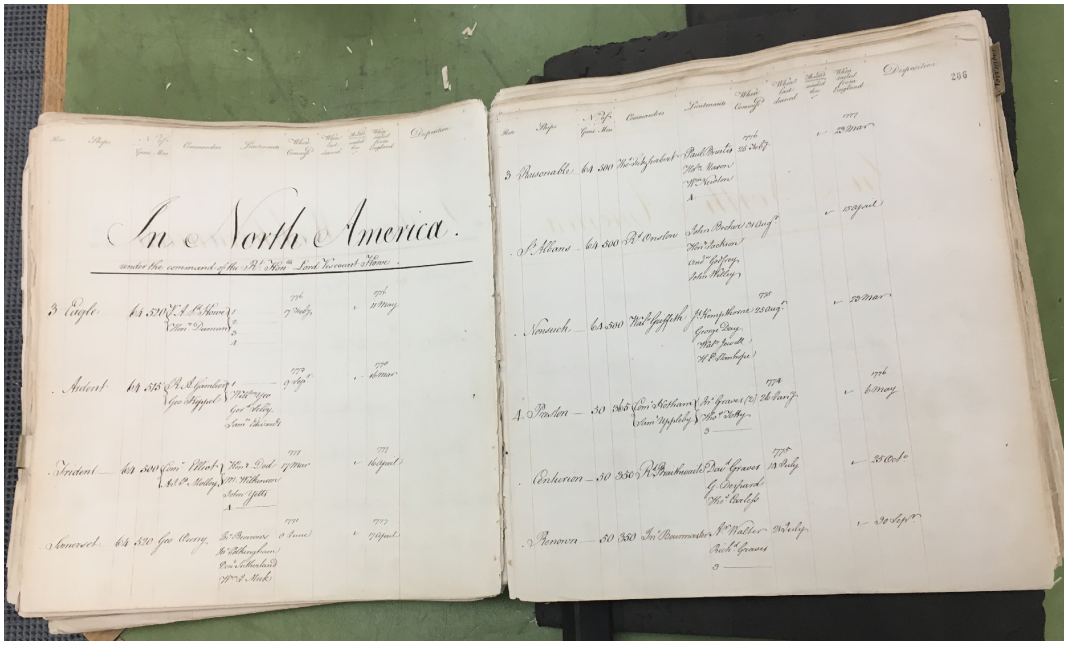
Table A13: Group statistics and pairwise comparisons - facial difference

Group	Mean	Median	Std. Dev.	Significance
Same person	0.4257	0.4074	0.1592	–
Father-son	0.5154	0.5086	0.1941	p = 0.008[a]
Random pairs	0.5973	0.5795	0.1695	p = 0.019[b]

Notes: Similarity measure from the DeepFace Python package, based on facial characteristics. Distance is $1 -$ similarity. [a] Significance level for Same Person vs Father-Son comparison (t = -2.793). [b] Significance level for Father-Son vs Random Pairs comparison (t = -1.993).

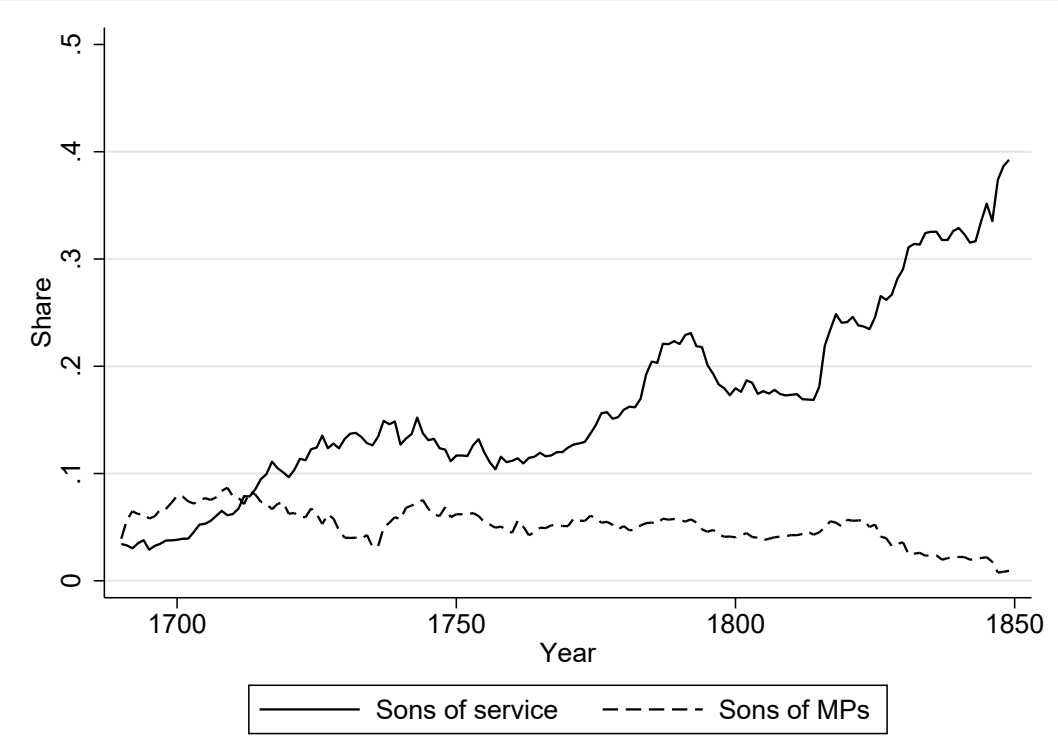
A.2 Appendix Figures - For Online Publication

Figure A1: Sample page - Royal Navy station lists



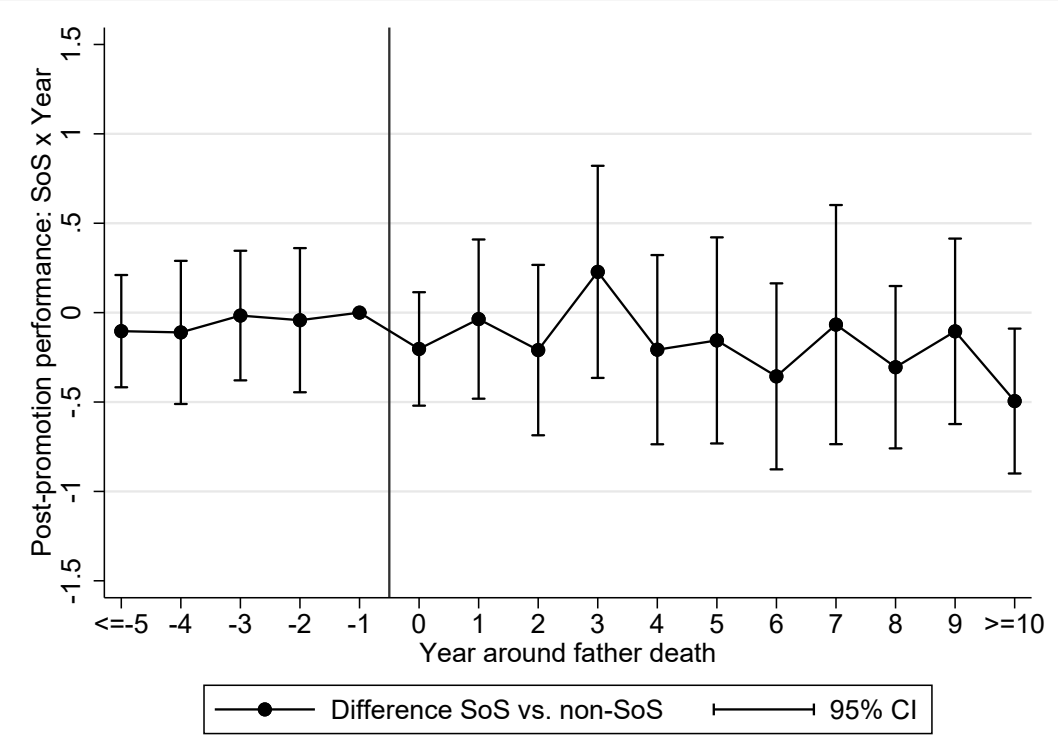
Notes: Sample of a page from the Admiralty Lists ("The present disposition of his Majesty's Ships and Vessels in Sea Pay") from 1778 (ADM 8), available at National Archives, Kew.

Figure A2: Sons of service and sons of MPs among post-captains



Notes: Figure shows the share of naval officers who are sons of service (defined as being the son, grandson, or nephew of a naval officer) and sons of MPs over time.

Figure A3: Performance around father's death: sons of service vs. non-SoS



Notes: Figure shows the performance difference between sons of service and non-legacies around the death of the officer's father. The coefficients are estimated conditional on officer, ship, and time FEs, with standard errors clustered at the officer-level. Reporting 95% CI intervals.

Figure A4: 3DDFA landmark recovery



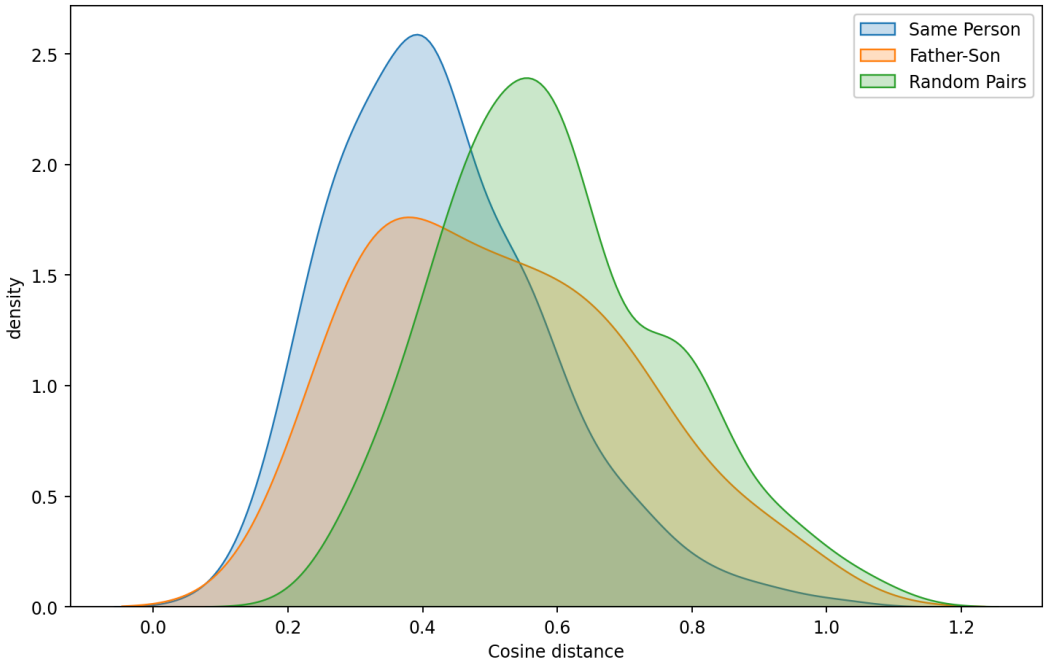
Notes: These are portraits the captains Charles Powell Hamilton (top row) and Sir Roger Curtis (bottom row). Because of the degree to which the officers' faces are turned, the two-dimensioanl landmark detection of dlib fails, as the left column shows. We use the 3DDFA library to infer their landmarks and recover them to the sample. The library uses geometric clues in the visible part of the face to infer landmarks on the turned part of the face. We then project these three-dimensional faces onto a 2 dimensional, flat plane as visualised in the third column, and use these extracted landmarks to score the officers' personality traits.

Figure A5: Portrait of Horatio Nelson



Notes: Portrait painting by William Beechey, 1801; oil on canvas; St. Andrews' Hall, Norwich.

Figure A6: Facial similarity distributions for fathers, sons, and random pairs



Notes: The figure plots distributions for facial similiarity. We use the deepface python library to compile a measure of distance based on the cosine similarity of facial landmarks for the same individual, random pairs, and father-son pairs, using the VGG-Face model.

Figure A7: Portraits of George Byng, 1st Viscount Torrington



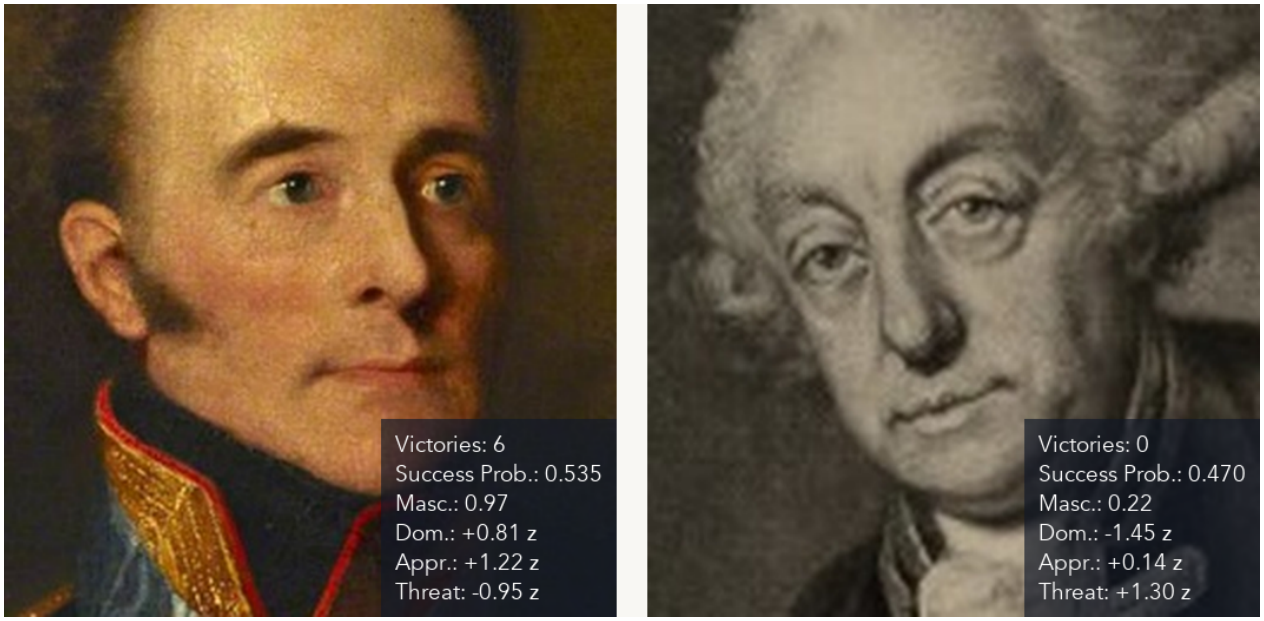
(a) Portrait Painting by Godfrey Kneller, 1707-09



(b) Portrait Painting by Jeremiah Davison, 1733

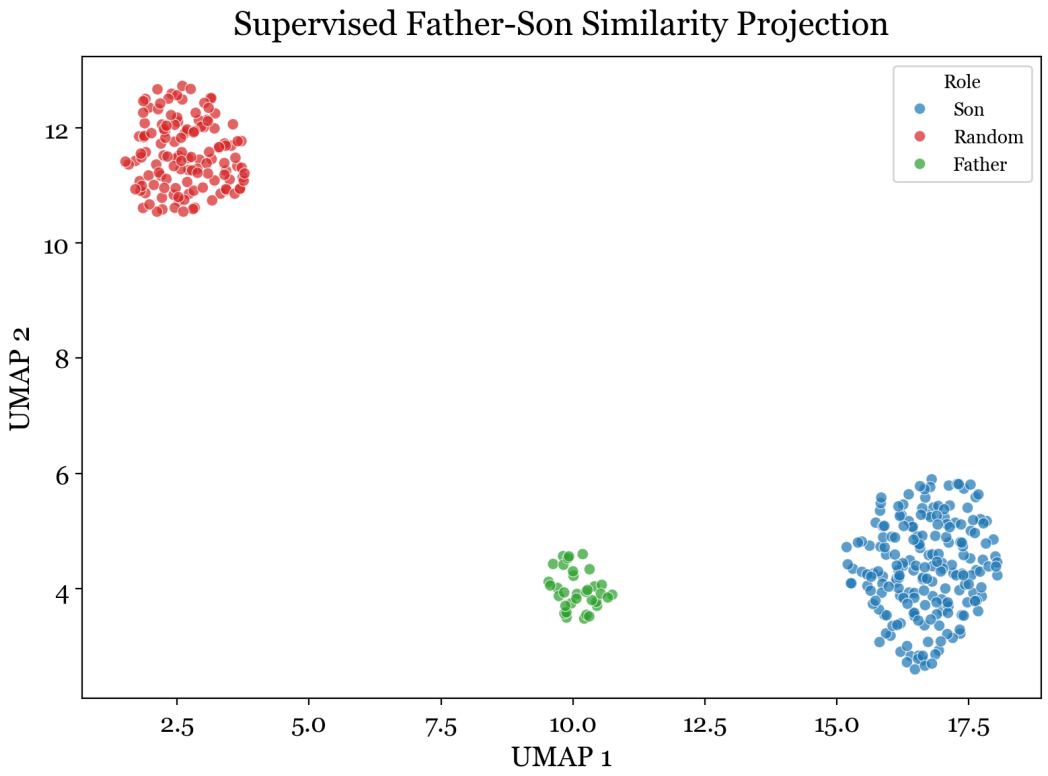
Notes: The figure shows two portraits of George Byng, 1st Viscount Torrington (1663–1733). The left was painted by Godfrey Kneller, started in 1707, and completed in 1709, when Byng was 46 years old. The right picture shows Byng after his victory at Cape Passaro (1718). It was likely painted in the year of his death, 1733, or shortly thereafter, when Byng was 60. Note the similarity of facial features, in particular, the length and shape of the nose, mouth, and eyebrows.

Figure A8: Personality trait scores of two naval officers



Notes: The image shows portrait paintings of Sir Thomas Ussher and Philipp Affleck, and reports their masculinity and CFD based personality trait scores. Sir Thomas Ussher had 6 naval non-fleet victories, Philipp Affleck had none.

Figure A9: Facial similarity of sons of service with their fathers vs. random captains



Notes: The figure shows a supervised UMAP projection of DeepFace portrait embeddings into two dimensions. Each dot represents one portrait, coloured by their group: fathers, sons of service, and randomly selected other captains. Because the projection is supervised, it is intended as a visualisation of group separation rather than a direct metric in itself. In this representation, the son and father portraits lie closer to one another than either does to the random comparison portraits, which is consistent with greater facial similarity between fathers and sons than between sons and unrelated captains in our sample. In the context of the broader argument, the figure supports the interpretation that some of the facial features associated with naval success are not only predictive at the individual level, but also partly transmitted across generations.

A.3 Portraits vs. Photograph Comparisons

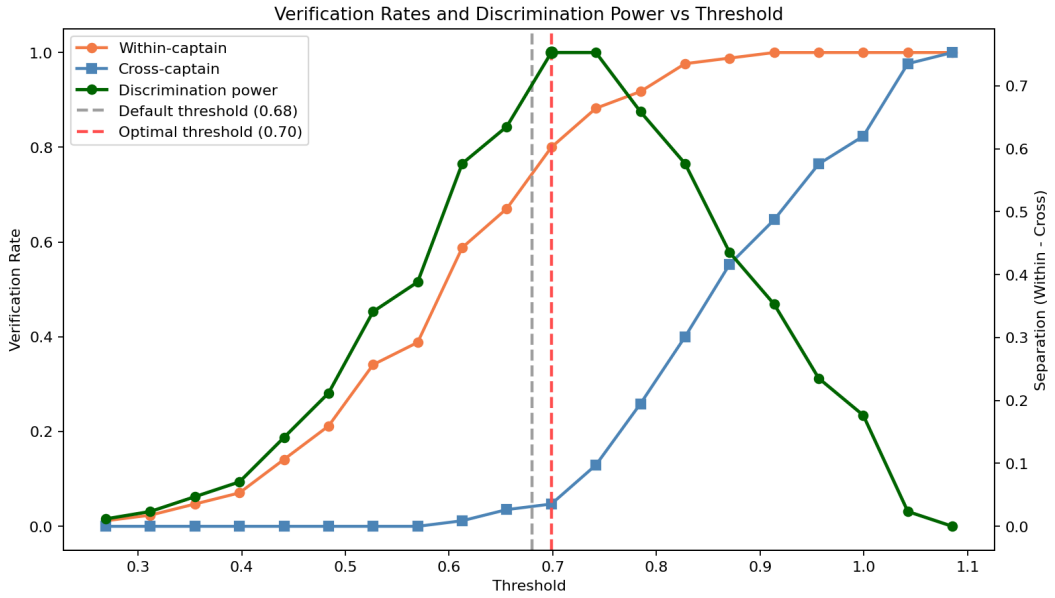
To assess whether painted portraits preserve the facial characteristics of the sitter, we compare portraits and photographs of the same individuals using a DeepFace verification exercise. For this validation step, we use a broader historical sample that includes not only naval captains, but also famous politicians, especially U.S. Presidents and U.K. Prime Ministers, as well as European royals, all of whom are known to have both painted portraits and photographs. The resulting sample spans a long historical range, from mid-nineteenth-century works to modern images, including for example Prince Harry. In the current comparison set, the analysis contains 85 within-person portrait-photograph pairs and cross-person pairs. If portraits preserve stable facial structure, true portrait-photograph matches should be verified substantially more often than mismatched pairs.

Table A14: DeepFace verification summary for portrait-photograph comparisons

group	mean verification rate	std	n
within-captain	0.765	0.427	85
cross-captain	0.047	0.213	85
comparison	cohen's d		p[a]
within > cross (verification rate)	2.1		< 0.001

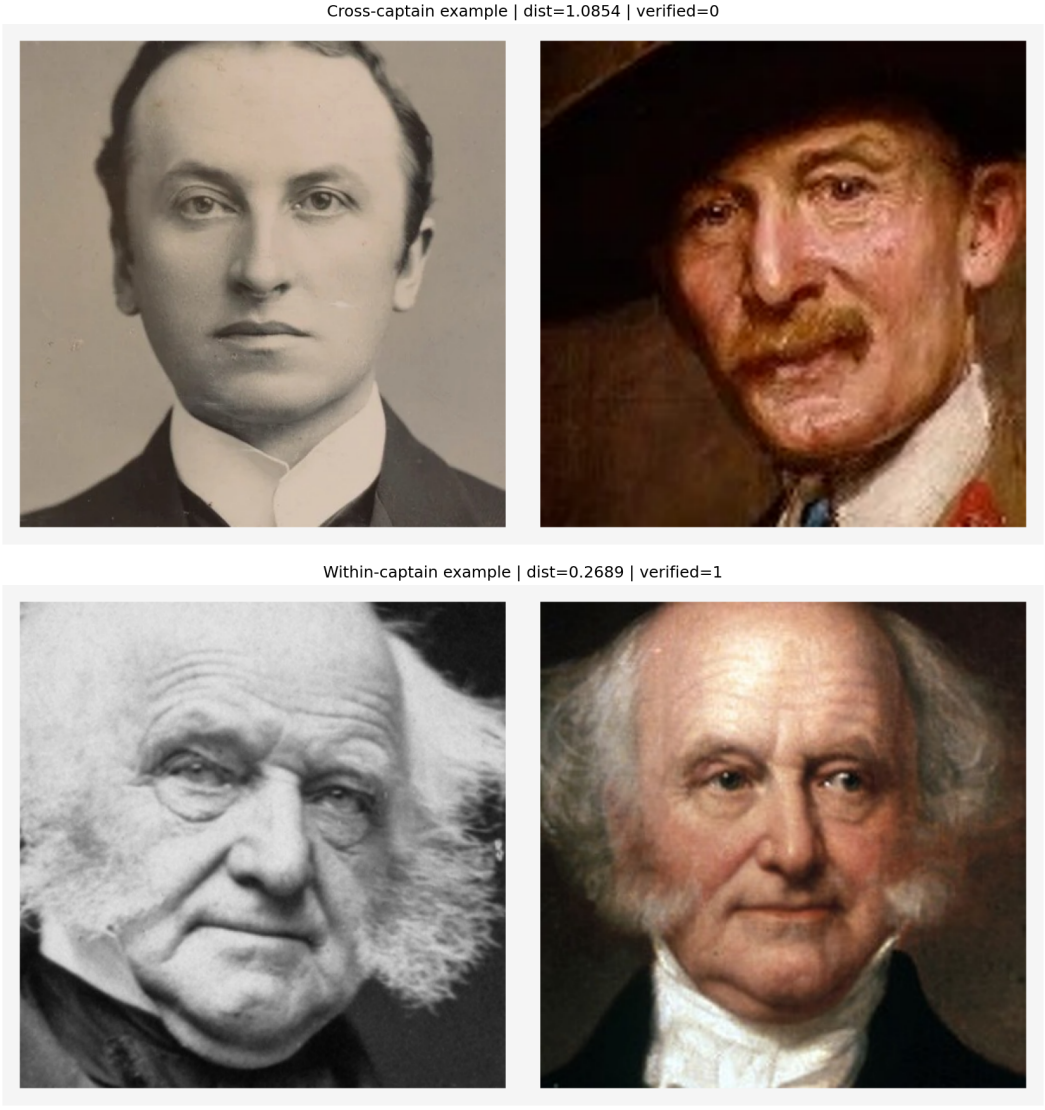
Notes: The table reports DeepFace verification outcomes for portrait-photograph comparisons. "Within-captain" refers to pairs in which the portrait and photograph depict the same individual, while "cross-captain" refers to mismatched pairs composed of different individuals. The verification rate is the share of pairs classified by the model as the same person. The table reports the mean verification rate, standard deviation, and number of evaluated pairs for each comparison group. The final row reports two summary statistics for the difference between within- and cross-captain verification outcomes. Cohen's d measures the size of the difference in standardized units and is therefore an effect-size measure: larger absolute values indicate a stronger separation between the two groups. [a]The Mann-Whitney p-value is a nonparametric test of whether verification outcomes in the within-captain group tend to be systematically higher than those in the cross-captain group. Statistically significant higher verification rates for within-captain pairs indicate that portraits preserve enough facial information for the sitter to remain recognizable across media.

Figure A10: Photo vs. portrait ArcFace model threshold analysis.



Notes: This figure presents an optimal threshold analysis for the portrait vs. photo similarity analysis. The optimal threshold in the sample is approximately 0.7, highlighted by the red vertical line. Here, the gap between within-captain and cross-captain comparisons is largest. The out of the box threshold of ArcFace is 0.68, marked with grey vertical line, and thus close to this optimum, implying that the standard threshold already provides near maximum discrimination between true and false within-captain matches.

Figure A11: Photograph vs. portrait similarity comparison



Notes: Panel one compares a photograph of an officer and a portrait of another, the second compares the photograph and the portrait of the same captain. We use the ArcFace model of the DeepFace library to determine the similarity distance and make a decision to verify whether both are of a captain with the same identity.