Shared Group Membership Facilitates the Persistence of Culturally Transmitted Behaviour

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ABSTRACT

Cultural transmission allows humans, and several other species, to create distinct cultural traditions and cultural repertoires. While the spread of innovations is well researched, much less focus has been given to factors allowing for novel behaviour to persist within a group so that novelties become cultural traditions. Here we show experimentally that group membership is a key factor in determining the stability of horizontally transmitted behaviour, and corroborate our findings with immigrant survey data. In two experiments, the perception of a shared group membership led to persistence of transmitted behaviour (tapping speed) across several days, indicating long-term stability. In contrast, where no shared group membership was perceived, transmitted behaviour was shown during immediate interaction with others but was quickly lost over time, indicating short-lived compliance. Consistent with our findings, a re-analysis of survey data from British Bangladeshi migrants indicates that identification with the host group facilitates horizontal transmission. Our data suggest that group membership is of considerable importance for our understanding of cultural diversity, immigrant acculturation, and the maintenance of behavioural change. Our study highlights the hitherto underappreciated relevance of social factors in our understanding of cultural transmission and evolution.

Introduction

In humans and across a wide range of animal species, novel behaviour can be passed on to other conspecifics via social learning (or cultural transmission) and become a stable cultural norm or tradition¹⁻⁷. Persistence is a key criterion for culture⁸. At the group level, persistence is a necessary condition for a novel behaviour to become part of the cultural repertoire of that group⁹. At the level of the individual, novel behaviour needs to be maintained to allow for the strongest chance of transmission, both horizontally amongst peers and vertically or obliquely between generations².

A number of factors have been proposed that facilitate the persistence of socially acquired behaviour⁸. Many of these factors relate to how effective and rewarding the behaviour is compared to alternative behaviours¹⁰. Imitating the novel behaviour could lead directly to a desirable outcome (e.g. food) or it could induce others to provide social rewards (e.g., affiliation or cooperation). Hence, individuals are thought to imitate others' behaviour for informational or normative reasons, or a combination of both¹¹. Informational and normative conformity, in turn, have been linked to the stability of the acquired behaviour¹². Informational conformity is thought to create a permanent behavioural change because the newly acquired behaviour makes a desirable outcome more likely, thus being directly rewarding. In contrast, normative conformity is thought to be relatively unstable as the chances of a reward or punishment are contingent on the co-presence of others. From this perspective, social factors should only promote short-term, context-dependent compliance.

The distinction between informational and normative conformity, however, has received surprisingly little empirical support¹³. Teasing apart the individual contributions of normative and informational conformity has proven to be empirically challenging, with studies showing that even in private situations where actions are hidden from others individuals show normative conformity at similar levels to public situations¹⁴. In addition, there appears to be no simple relationship between the type of conformity and the persistence of the acquired behaviour¹⁵.

Here we will test an alternative theory from social psychology that proposes group membership - rather than the type of reward - as a key variable that determines the persistence of socially acquired behaviour. More specifically, this theory suggests that novel behaviours are more likely to persist when acquired from other members of one's own group¹⁶. In such cases, the source of the information is considered trustworthy and the behaviour is marked out as appropriate for members of the group. Importantly, group members are not merely imitating behaviour for affiliative reasons. Instead, they may judge the information to be relevant and adaptive for themselves based on their shared group membership with others. In addition, group members may show the acquired behaviour as an expression of a valued group membership¹⁷. This means that behaviour

acquired from in-group members should persist beyond the social context in which it was acquired, and in the absence of other in-group members. In contrast, when the group membership of demonstrators is not recognised as being the same as that of the learner, the learner might still imitate the behaviour for short-term social reasons but is less likely to show it outside that social context. To put it differently, behavioural change acquired from members of one's own group is expected to facilitate long-term persistence, whereas behavioural change acquired when no shared group membership is perceived with the demonstrator is expected to produce short-lived compliance.

Studies of social learning show that, from an early age, humans take social group membership into account when acquiring novel behaviour through imitation^{18–20}. For instance, research shows that, at 14 month of age, children imitated the actions of an in-group member more faithfully than the same actions by an out-group member¹⁸. However, research is currently missing that tests the persistence of socially learned behaviour, rather than fidelity in acquisition, and the role group membership plays in this.

Empirical evidence for the spread and persistence of culturally transmitted behaviour largely stems from seeding experiments with non-human animals^{4,21,22}. A member of the group is trained to perform a novel behaviour, and the extent to which the novel behaviour spreads amongst the group and persists over time is then observed. In such studies, however, the demonstrator is usually from the same social group as the learner, often occupying a central position within the group. This leaves open the question whether those who do not perceive a shared group membership with the demonstrator, such as recent immigrants, persist with the newly acquired behaviour to the same extent as established group members.

We hypothesise that socially transmitted behaviour will be preferentially maintained when acquired from those with whom one shares a group membership. In other words, horizontally transmitted behaviour is most likely to persist when a shared group membership is recognised with the demonstrator. We tested this hypothesis in a longitudinal laboratory experiment, a more tightly controlled replication experiment, and by re-analysing an existing dataset collected with a survey of British Bangladeshi migrants in the UK²³.

Results

In the first laboratory experiment participants were exposed to distinctive tapping behaviour by confederates in one of two conditions: Subjects were either reminded of a social group membership (social identity condition), or they were reminded of their identity as an individual (personal identity condition). The social group membership was chosen to be broad enough for individuals to assume that others in the experiment (i.e., the confederates) shared this group membership. This manipulation was chosen as it has been argued to exclude a number of confounds commonly found with stronger manipulations of shared identity²⁴. In particular, our manipulation should reduce the risk of increasing similarity and familiarity in the social identity condition as both of these variables have been shown to affect persistence of imitated behaviour²⁵. In order to avoid increasing a sense of similarity with the demonstrators beyond sharing a group membership, we chose a manipulation that asked participants to focus on their own relationship to the group rather than on commonalities with the other individuals in the experiment. In addition, the manipulation was introduced after baseline testing when the confederates were not yet in the room, with no communication between participants and confederates during the experiment. To exclude familiarity, the same unfamiliar confederates were used in both conditions. We also avoided introducing out-group threat as a confound by choosing personal identity as a control condition rather than a relevant out-group²⁴.

We used an entrainment task to assess persistence of behavioural change as entrainment has been found to be spontaneous²⁶. Hence, differences in persistence can emerge independent of an in-group bias during acquisition. Participants were asked to tap an isochronous rhythm²⁷ by themselves (baseline), in the presence of two confederates/demonstrators (entrainment) and again by themselves directly after the entrainment phase (follow-up 1; $F1$), 24 hours later (follow-up 2; $F2$), and 48 hours later (follow-up 3; $F3$), respectively. Confederates were introduced as fellow participants and were trained to tap in synchrony at an unusually fast speed of $3Hz$ ²⁸.

The basic design of the replication experiment was the same as the initial experiment. However, the replication study differed in three important ways: (1) participants were joined by two confederates online – each person being represented by a flickering dot that emitted a sound for each tap; however, participants were unaware that the dots of “confederates” were controlled by the experimental software rather than a person thereby giving us more experimental control of the confederates’ tapping speed, (2) the virtual confederates tapped slightly faster at $3.2Hz$ instead of $3Hz$ than in the initial study in order to make behavioural change more apparent, (3) persistence was assessed across four days rather than two in order to assess how long participants would persist in the entrained behaviour.

Effects of group membership on persistence under laboratory conditions

Results of both laboratory experiments show clear evidence of a social in-group bias in persistence (for Experiment 1 see Figure 1 and Table 1; for Experiment 2 see Figure 2 and Table 2). Growth trajectories fitted with a multilevel model indicate that participants who perceived a shared group membership with the peer demonstrators were significantly more likely to persist

with a changed tapping speed for up to two days in Experiment 1 (change over time: $p = .378$), and for up to five days in Experiment 2 (change over time: $p = .174$). Participants who tapped without awareness of a shared group membership to the peer demonstrators showed no persistence and tended to revert back towards their baseline speed (change over time: $p = .004$ in Experiment 1, $p = .033$ in Experiment 2).

This effect was not due to differences in acquisition. Participants in both conditions changed their tapping speed significantly from baseline (change over time: $p = .003$ in Experiment 1, $p = .029$ in Experiment 2). Baseline speed was also comparable between conditions (Experiment 1: two-tailed t -test, $t(36) = 1.37$, $p = .180$, Cohen's $d = 0.45$; Experiment 2: $t(38) = 0.57$, $p = .572$, Cohen's $d = 0.18$). Manipulation checks were successful: In Experiment 1, participants perceived more homogeneity amongst students in the social identity condition ($M = 4.68$, $s.e.m = 0.24$) than in the personal identity condition ($M = 3.80$, $s.e.m = 0.29$; two-tailed t -test, $t(36) = 2.32$, $p = .026$, Cohen's $d = 0.75$). In Experiment 2, participants identified more strongly with being a student in the social identity condition ($M = 5.43$, $s.e.m = 0.16$) than in the personal identity condition ($M = 4.97$, $s.e.m = 0.14$; two-tailed t -test, $t(38) = 2.19$, $p = .035$, Cohen's $d = 0.69$).

Individual-level short-term and longer-term behavioural changes

In Experiment 1, four participants (21%) in the personal identity condition and one participant (5%) in the social identity condition failed to entrain (criterion: $> |0.1|Hz$ change from baseline by the last minute of entrainment). In both conditions, two participants (11%) entrained but showed no persistence at follow-up (criterion: $> 0.2Hz$ reduction in speed compared to last minute of entrainment). A further seven participants in the personal identity condition (37%) and three participants in the social identity condition (16%) showed short-term persistence directly after entrainment but reduced their tapping speed after 24 hours. A total of six participants in the personal identity condition and 13 participants in the social identity condition showed long-term persistence, that is, they did not reduce their speed by more than $0.2Hz$ compared to their entrainment speed across three days. Hence, significantly more participants in the social identity condition (13 of 19; 68%) showed long-term persistence than in the personal identity condition (6 of 19; 32%; one-tailed Fisher's exact test, $p = .025$).

Experiment 2 showed a similar pattern of results: Here, all participants entrained. In line with our hypothesis, more participants in the social identity condition (11 of 20; 55%) showed long-term persistence across five days than in the personal identity condition (5 of 20; 25%; one-tailed Fisher's exact test, $p = .053$).

Immigrant adoption of host cultural values

In addition to the two experiments, we analysed an existing dataset that presented us with the opportunity to test our hypothesis outside the laboratory. First-generation and second-generation British Bangladeshi immigrants to the UK had participated in a survey assessing vertical and horizontal transmission²³. In that study, evidence for horizontal transmission from the host culture to the immigrant population was found for immigrants' endorsement of the Western value of individualism. More specifically, the extent to which print media (newspaper and magazines) of the host culture were consumed predicted the extent to which immigrants endorsed values related to individualism. In addition, identification with the host culture was assessed but not tested as a predictor in the original study. This constellation meant that we could test whether identification with the host culture facilitated the effect of print media (the "demonstrator") on horizontally transmitted behaviour. However, as this dataset was not designed to test our hypothesis, and the identity of the "demonstrator" (print media) was different to that in the experiment (confederates), results need to be interpreted with the appropriate caution.

The re-analysis of immigrant data corroborates our findings from the laboratory (see Figure 3): Moderation analysis indicates that identification with the host culture interacts with the effect of print media (the "demonstrator") in predicting individualism of first- and second-generation immigrants (interaction effect: $b = .03$, $s.e.m = 0.01$, $p = .026$; main effect print media: $b = -.09$, $s.e.m = 0.06$, $p = .112$; main effect identification: $b = -.09$, $s.e.m = 0.03$, $p = .005$). In line with our hypothesis, we found that the extent to which British Bangladeshi immigrants to the UK consume UK print media significantly predicts their agreement with individualistic values only when they identify highly with the UK (simple slope at 1SD above the mean: $b = .07$, $s.e.m = 0.02$, $p = .005$) but not significantly when their identification with the UK is relatively low (simple slope at 1SD below the mean: $b = .00$, $s.e.m = 0.02$, $p = .987$). Interestingly, the effect of immigrant status (first- or second-generation) no longer predicted individualism once identification was included in the model ($b = -.04$, $s.e.m = 0.03$, $p = .143$). However, it needs to be noted that the interaction effect between print media and identification – but not the main effect of identification – is reduced below conventional levels of significance when identification with the heritage culture is included in the analysis.

Discussion

Social group membership affects social learning in humans from an early age¹⁸. Previous studies have shown that in-group members' behaviour is more likely to be acquired, and with greater fidelity, than out-group members' behaviour^{18–20}. However, reward-based models of the stability of behavioural change suggest that social factors such as group membership are unlikely

to produce persistent behavioural changes, and that acquired changes are unlikely to be shown when in-group members are absent^{11,12,15}. In contrast, predictions derived from a theory of group membership suggest that behaviour acquired from an in-group member should be particularly likely to persist over time, even in the absence of others¹⁶.

Our data support the latter theory, showing that the perception of a shared group membership with demonstrators facilitates longer-term stability of behavioural change rather than producing only short-lived compliance. Individuals who changed their behaviour to be in line with behaviour by fellow group members tended to continue with the changed behaviour for several days, even in the absence of the demonstrators or any other in-group members. In contrast, where no shared group membership was perceived with demonstrators, individuals preferred to return towards their initial behaviour shortly after acquisition. Furthermore, our re-analysis of migrant data²³ provides an initial indication that group membership may affect horizontal transmission outside the laboratory in line with our prediction.

In contrast to most seeding and diffusion chain experiments, the tapping task in our experiments was not goal-directed and was not rewarded. Hence, the demonstrators' behaviour had little informational value other than to reduce uncertainty in a new task. Similar to situations outside the laboratory, any perceived social rewards (e.g. acceptance by others) were limited to the acquisition situation and unavailable in the follow-up sessions where only the experimenter was present. Even in such low-stakes environments, horizontally transmitted behaviour persisted, particularly when it was acquired from fellow group members.

The non-instrumental aspect of the task means that behaviour of the peer demonstrators was most likely interpreted as a social convention²⁹. Social conventions and rituals are important aspects of human societies. However, it remains open whether a more instrumental task would have produced similar results. For instance, individuals may persist with a newly acquired instrumental behaviour irrespective of who they acquired the behaviour from because it directly leads to desirable outcomes¹². However, there are a number of situations where adopting new instrumental behaviour may not be more effective and may even be associated with costs. For instance, in temporally nonstationary situations, acquiring and persisting with socially learned behaviour can be costly as the behaviour may become ineffective over time³⁰. In these more ambiguous situations, group membership may affect persistence even for instrumental tasks.

With regard to the experimental results, it needs to be noted that not all individuals in our experiments showed the predicted pattern. More specifically, in Experiment 1, not all individuals entrained to the faster tapping speed. In line with research on learning styles, this lack of entrainment might indicate that some individuals are unresponsive to social information^{31,32}. However, the finding that all participants changed their tapping speed in Experiment 2, where demonstrator speed was faster, suggests that entrainment might be more contingent on a sufficient difference to individuals' baseline speed rather than on individuals' social learning style.

Our data also show that most individuals did not entrain perfectly to the unusually fast speed set by the demonstrators, and that some participants went well above the speed demonstrated. This suggests that fidelity is not particularly high, even when the task is an entrainment task, conventional rather than instrumental, and a majority of individuals in the situation (two demonstrators to one naïve participant) shows the behaviour. Although individuals might not have managed to entrain perfectly to the demonstrated speed, they might have interpreted the unusually fast speed of the demonstrators as a norm to tap fast, or even as fast as possible, rather than as a norm to tap at exactly 3 or 3.2 Hz, respectively. This might also explain why a few individuals in the social identity condition increased their tapping speed steadily in the follow-up sessions in Experiment 2.

Analysis of individuals in the experiments show that not all participants in the social identity condition persisted with the socially acquired behaviour and, conversely, that a few individuals in the personal identity condition persisted. Although it is speculative why not all participants in the experimental conditions behaved in the predicted way, one possibility is that our manipulation was not effective with these individuals. Participants in the social identity condition who did not persist might not have perceived themselves and the demonstrators as members of a shared social group. In order to avoid making similarity salient to participants in the social identity condition, we left it to participants to perceive a shared group membership with the demonstrators rather than making this link explicit. Equally, those in the personal identity condition might still have perceived a shared group membership with the demonstrators despite being reminded of their own personal identity. For instance, common fate - such as being a participant in the same experiment - has been shown to create temporary but meaningful social group memberships³³. However, the overall pattern of results clearly indicates that social group membership is an important factor in the persistence of horizontally transmitted behaviour.

Looking at the wider implications, the demonstrated effect of social group membership on persistence may provide an alternative account to majority bias in conformity in explaining the heterogeneity between cultures and the homogeneity within cultures in fission-fusion societies. Recent findings suggest that imitation is not sufficiently high in fidelity to account for the stability of local cultures⁸. The facilitating effect of group membership on persistence allows for stable cultural traits to emerge where a shared group membership exists and works against the persistence of transmission where it occurs between social groups. Temporary immigrants to a group are likely to show compliance and adopt the local variant whilst in the presence of others. However, a persistent change in behaviour is only likely to emerge when a shared group membership with the host

group is perceived.

The potential role of perceived group membership in cultural evolution also ties in with the findings by a recent simulation of human innovation: Large, partially connected populations were found to be the most successful constellation for producing complex innovations³⁴. Humans' cognitive ability to categorise self and others into large-scale, cross-cutting social groups³⁵, and the effect of such categorisation on social learning, might have been pivotal in producing humanity's extraordinary ability for cumulative culture and innovation. Indeed, it has been argued that natural selection might have favoured group markers and behaviour based on group norms to evolve together³⁶. Large scale categories such as nations, ethnic groups, or religious groups demonstrate that humans can perceive a shared group membership with a large number of strangers in the absence of direct face-to-face interaction and show persistent behaviour in line with these groups' norms. Our replication experiment with virtual confederates shows that the effect of group membership on the persistence of socially acquired behaviour is indeed robust in the absence of face-to-face contact during acquisition.

However, humans are not the only species that organises in fission-fusion societies³⁷. Non-human animal studies examining persistence are needed to test for effects of shared group membership. For instance, seeding experiments could be adapted to include a condition where members of a different group act as demonstrators, and where animals are tested outside the social context in which the behaviour was acquired. The main difficulty in testing group membership effects with animals is that group membership is strongly related to proximity, similarity and familiarity, making it particularly difficult to disentangle these factors.

In conclusion, our findings indicate that group membership is an important factor in understanding the persistence of horizontally transmitted behaviour, with implications for understanding immigration, diversity and lasting behavioural change.

Methods

A total of $N = 40$ human adults participated in Experiment 1. However, two participants missed two sessions due to illness, and their data were excluded from analyses, leaving a final sample of $N = 38$. Sample size and number of follow-up sessions were determined based on two smaller preparatory studies. We used "student" as the social group membership. We therefore recruited only undergraduate students from the University of Exeter. The majority of participants were women ($n = 28$, 74%), with an average age of $M = 20.63$, $SD = 4.00$, who studied a variety of different subjects. Participants were recruited through various university mailing lists. Participants were reimbursed with £5 per attended session.

The study was approved by the Ethics Committee of the Department of Psychology, University of Exeter, prior to commencement and was carried out in accordance with the British Psychological Society's ethics guidelines. All participants received an information sheet and gave informed consent upon entering the lab. They were seated at the short end of a rectangular table, with a tapping board in front of them, and one tapping board to their left and right respectively. Each tapping board consists of a rectangular blue wooden box, with a sensor integrated into the box at the top end, a circuit board inside the box, and a cable extending from the tapping board to a receiver box that was connected to a laptop via USB. Participants were told to tap an isochronous rhythm with their index finger of their dominant hand on the tapping board at a speed of their own choosing. They were informed that they should start at a signal from the laptop in front of them when it showed the letters GO in green and stop when it said STOP in red. Participants were told that they would tap five trials of 45 sec, with 15 sec breaks in-between to avoid fatigue. After a brief test phase, the trials of the baseline measurement started. Upon completion, participants were given a survey that contained the social group manipulation instructions³⁸. Participants were randomised to conditions using simple randomisation and computer generated random numbers. In the social identity condition, participants were asked to name four things that "[they] and other students do well/badly/often/rarely". Participants in the personal identity condition were asked to name four things that "[they] as an individual do well/badly/often/rarely". This was followed by a manipulation check question assessing homogeneity perceptions of the group in question³⁹. While participants filled in the survey, the experimenter went to two adjacent rooms to fetch two other participants (i.e., the peer demonstrators). A female and a male peer demonstrator were placed at the left and right of the participant, respectively, in front of the additional tapping boards. All three individuals were then instructed to tap at a speed of their own choosing for five trials as before. The peer demonstrators synchronised during the first trial at a speed of 3Hz and stayed synchronised at this speed throughout the other trials. After the entrainment phase, peer demonstrators were led back to the adjacent rooms. The participant was then asked to tap for another five trials by themselves ($F1$). Participants were asked to return 24 hours ($F2$) and 48 hours ($F3$) later for another five trials of tapping by themselves, respectively. After the last tapping session, participants were debriefed by the experimenter. None of the participants expressed suspicions about the peer demonstrators.

Prior to data analysis, the first five taps of each trial were removed from the data as well as any outliers of 3SDs above and below each participant's individual mean. Tapping data were recorded in msec between taps. For easier interpretation, tapping data were transformed to Hz before analysis. Baseline data, data from $F1$, $F2$, and $F3$, respectively, were aggregated across the five trials to generate a reliable speed value. To allow for examination of behavioural change during entrainment, data were aggregated for each of the five entrainment trials separately. Outliers of 2.5SD above or below the overall mean were excluded

from analysis. Growth curves for both the entrainment and follow-up models were fitted with multilevel modelling using the MIXED command in IBM SPSS 22. An autoregressive covariance matrix was used for level 1 (time), and a diagonal covariance matrix was used for level 2 (person). Both intercept and slopes were allowed to vary randomly. For the analysis of individual tapping behaviour, a change of at least 0.1 Hz from baseline by the last of the five entrainment sessions was considered a change in speed; the threshold of 0.1 Hz is based on literature showing that humans find it difficult to detect, or correct, fluctuations of 0.1 Hz and below⁴⁰. For persistence in the follow-up sessions, a criterion of 0.2 Hz was chosen as the change followed a break in tapping of 24 h, and participants may have changed in either a faster or slower direction, respectively.

A replication study was conducted with $N = 40$ British undergraduate students from the University of Exeter (73% women; age: $M = 19.18$, $SD = 0.90$). The study was approved by the Ethics Committee of the Department of Psychology, University of Exeter, prior to commencement and was carried out in accordance with the British Psychological Society's ethics guidelines. All participants received an information sheet and gave informed consent upon entering the lab; all participants were debriefed at the end of the study and received £2.50 per attended session. Participants were randomised to conditions using simple randomisation with computer-generated random numbers. Social identity salience and personal identity salience were manipulated in an identical way to the initial study. Participants were then asked to tap at a speed of their own choosing on the keyboard of a computer while watching a red dot at the bottom of a black background flicker with an accompanying clicking sound in time with their tapping. Tapping speed was measured as the time between two taps in msec with the computer software Inquisit 4⁴¹. After baseline measurements were taken for 5 x 45 secs, participants were told that two participants, who were placed in adjacent rooms on computers, would be joining them in the tapping task. After a short waiting period, a purple dot appeared in the top left corner, and shortly after that an orange dot appeared in the top right corner. Participants were then given a start signal and started tapping, with their own tapping represented by the red dot as before. The purple and orange dot converged shortly after the start signal at a speed of 3.2 Hz. After the five entrainment trials, the dots disappeared and participants were asked to provide responses on a 7-point scale to four items that measured their identification as students (e.g. "I identify with other students")⁴². The internal consistency of the scale was Cronbach's $\alpha = .52$, after excluding the item "I see myself as a student". Participants were then asked to tap again by themselves and to return every 24 hrs for another tapping session for five consecutive days in total. In order to control for effects of the experimenter or the room, half of participants had their initial session with a different experimenter and in a different room than the follow-up sessions. We found no significant differences between the two groups in tapping speed or group identification (all $ps > .200$). Analyses were conducted as in Experiment 1.

The re-analysis of survey data²³ was restricted to datasets from $N = 78$ first- and second-generation British Bangladeshi immigrants to the United Kingdom, all living at the time of data collection in the Tower Hamlets borough of London. Non-immigrant data were excluded from the original dataset as well as incomplete datasets. In the study, a first-generation Bangladeshi immigrant is defined as an individual who was born in Bangladesh and who moved to the UK after the age of 14, with both parents also born in Bangladesh. A second-generation Bangladeshi immigrant is defined as an individual who was born in the UK or moved to the UK before the age of 14 but whose parents were both born in Bangladesh. Participants filled in a survey with several scales. For a detailed description of the study and all material see the original publication²³. For our analysis, we used the following scales: UK print media use was measured with two items – "On average, how often do you read a UK-based daily [newspaper/magazine]?" Answers could be given on a scale from 1 = "less than once a month" to 4 = "every day". Items correlated significantly, with $r(78) = .34$, $p = .003$, and scores were therefore averaged.

Identification with the UK was assessed with the Vancouver Index of Acculturation⁴³. It consists of 10 items that were answered on a scale from 1 = "disagree" to 7 = "agree"; example item: "I often behave in ways that are typical for a British person not from my heritage culture." The scale had good internal consistency, with Cronbach's $\alpha = .88$, and scores were therefore averaged to form an identification with the UK scale.

Individualism was measured with eight items⁴⁴ that were answered on a scale from 1 = "strongly disagree" to 7 = "strongly agree"; example item: "I rely on myself most of the time; I rarely rely on others." The scale had acceptable internal consistency, with Cronbach's $\alpha = .67$. Scores on the individualism measure were averaged and then log-transformed before analysis due to non-normality.

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Author contributions statement

M.K. and M.L. designed the experiments; M.K. conducted the experiments and analysed the data; A.M. designed the survey study and analysed the data; M.K. wrote the paper; all authors discussed the results and implications and commented on the manuscript.

Additional information

Data availability The datasets for Studies 1 and 2 are available through UK Data Service ReShare. Data for Study 3 are available as part of an open-access publication²³. **Competing financial interests** The authors declare no competing financial interests.

Figure 1. Tapping speed (Hz) over time for social and personal identity conditions. (a) Baseline and all five entrainment trials - this graph shows that, on average, participants in both the social and personal identity condition increased their tapping speed from baseline when they tapped on their own until the end of the entrainment session during which two co-present confederates tapped at $3Hz$ in synchrony. (b) Follow-up sessions - this graph shows that, on average, participants in the personal identity condition decreased their speed away from the entrainment speed when they were tested on their own shortly after, $24hrs$ and $48hrs$ after entrainment; in contrast, participants in the social identity condition persisted with the entrainment speed over $48hrs$. Sample size: $N = 38$ (19 per condition); error bars show $\pm 1 s.e.m$ corrected for within-subject designs⁴⁵.

Figure 2. Tapping speed (Hz) over time for social and personal identity conditions in the replication study. (a) Baseline and all five entrainment trials - this graph shows that, on average, participants in both the social and personal identity condition increased their tapping speed from baseline until the end of the entrainment session during which two virtual confederates tapped at $3.2Hz$ in synchrony. (b) Follow-up sessions - this graph shows that, on average, participants in the personal identity condition reverted their speed back towards baseline speed when tested on their own shortly after entrainment and every $24hrs$ for four consecutive days; in contrast, participants in the social identity condition persisted with the entrainment speed across all five days of measurement. Sample size: $N = 40$ (20 per condition); error bars show $\pm 1 s.e.m$ corrected for within-subject designs⁴⁵.

Figure 3. Interaction between UK print media use and identification UK on individualism. The graph shows that host culture print media only affect the extent to which immigrants endorse the host cultural value of individualism when immigrants identify with the host culture (high identification UK) but not when they do not identify (low identification UK). Sample size: $N = 78$ first- and second-generation Bangladeshi immigrants to the UK.

Fixed effects	Full model	Separate models by condition	
		Social identity	Personal identity
Entrainment	Coefficient (s.e.m)	Coefficient (s.e.m)	Coefficient (s.e.m)
Intercept	2.08*** (0.16)	2.41*** (0.17)	2.08*** (0.15)
Time, linear	0.16** (0.05)	0.11* (0.05)	0.16** (0.05)
Time, quadratic	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Condition	0.33 (0.23)		
Time x Condition	-0.05 (0.07)		
Time ² x Condition	0.002 (0.01)		
Follow-up			
Intercept	3.21*** (0.26)	2.84*** (0.27)	3.21*** (0.25)
Time, linear	-0.72** (0.19)	-0.15 (0.16)	-0.72** (0.22)
Time, quadratic	0.16** (0.05)	0.03 (0.04)	0.16** (0.05)
Condition	-0.37 (0.37)		
Time x Condition	0.57* (0.27)		
Time ² x Condition	-0.13 (0.07)		

Note. * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$. All predictors are uncentred. Condition is coded 0 = personal identity condition, 1 = social identity condition; time (linear) and time (quadratic) start at 1. Entrainment models are based on baseline speed, and speed during five entrainment session trials; Follow-up models are based on speed of three follow-up sessions (directly after entrainment, 24hrs and 48hrs later), respectively.

Table 1. Multilevel growth-curve models for tapping speed (Experiment 1)

Fixed effects	Full model	Separate models by condition	
		Social identity	Personal identity
Entrainment	Coefficient (s.e.m)	Coefficient (s.e.m)	Coefficient (s.e.m)
Intercept	2.47*** (0.29)	2.20*** (0.26)	2.52*** (0.32)
Time, linear	0.34* (0.16)	0.42** (0.14)	0.32** (0.15)
Time, quadratic	-0.03 (0.02)	-0.05* (0.02)	-0.03 (0.02)
Condition	-0.26 (0.41)		
Time x Condition	0.07 (0.22)		
Time ² x Condition	-0.01 (0.03)		
Follow-up			
Intercept	3.80*** (0.34)	2.83*** (0.25)	3.82*** (0.39)
Time, linear	-0.42* (0.18)	0.22 (0.16)	-0.43* (0.20)
Time, quadratic	0.05 (0.03)	-0.02 (0.02)	0.05 (0.03)
Condition	-0.91 (0.48)		
Time x Condition	0.60* (0.26)		
Time ² x Condition	-0.06 (0.04)		

Note. * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$. All predictors are uncentred. Condition is coded 0 = personal identity condition, 1 = social identity condition; time (linear) and time (quadratic) start at 1. Entrainment models are based on baseline speed, and speed during five entrainment session trials; Follow-up models are based on speed of five follow-up sessions every 24hrs.

Table 2. Multilevel growth-curve models for tapping speed (Experiment 2)