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AN IMPEDIMENT TO CULTURALLY INFLUENCED IDENTITY PROCESSING OF GRASPABLE OBJECTS: A TYPOGRAPHIC INTERPRETATION

OTOBO, Audu Omar Ahmed / WATILA, Musa Mamman, / JAMES, Lucky
Department of Industrial Design/ Department of Neurology
University of Maiduguri, Borno State, Nigeria

Abstract
The learning examined whether interpretation acquisition has a cost for the recognition of non-multilingual visual materials based on the *neuronal recycling hypothesis* (Dehaene and Cohen, 2007). More explicitly, the learning tartan whether the ability to differentiate between mirror repeat images, which develops through literacy acquisition, impedes with object identity judgments, and whether impediment dominance varies as a function of the nature of the non-multilingual material. To this aims the learning presented illiterates, tardy literates (schooled through adult literacy classes), and early literates adults with an orientation-independent, identity-based same-different comparison task in which they had to respond "same" to both physically identical and mirrored or rotated images of pictures of familiar objects (Experiment 1) or of geometric shapes (Experiment 2) impediment from inappropriate orientation variations was dominant for with plane rotations than with mirror repeat images and dominant with geometric shapes than with objects. Illiterates were the only participants almost impassive to mirror variations, but only for familiar objects. Consequently, the process of unlearning mirror repeat images generalization, essential to acquire literacy in the Egu-yorubas alphabet, has a cost for indispensable function of the ventral object recognition stream, i.e., identification of familiar objects. This demonstrates that neural recycling is not just an alteration to flexible-use but a process of at least partial exaptation.

Keywords: Visual objects recognition, mirror repeat images, enantiomorphism, typographic acquisition.

Introduction

Theories according to Gould and Vrba, 1982, Jacob, 1987, concerning the task and the organization of the brain, it is relatively common for neural circuits reputable for one purpose to be distinguished or tinkered during evolution for instance*, the massive redeployment hypothesis, (Anderson, 2007a,b)* or the normal development *the neural recycling hypothesis,(Dehaene ,2009, Anderson, 2010).* The neuronal recycling hypothesis is particularly engrossed to the attainment of cultural innovations such as interpreting or reckonings that have emerged in mankind recently, precluding development to have uncommon cortical circuits devoted to these purposes. Thus, these cognitive abilities have to be eruditely and their *neuronal place* must be established, explicitly pre-existing neural system "that are suitably close to the required function and satisfactorily flexible as to reorient a significant fraction of their neural resources to this novel use" (Dehaene and Cohen, 2007).

Cultural learning is commonly facilitated by pre-existing cortical properties under this theory. For paradigm, typo-interpretation acquisition, several characteristics of the ventral visual pathway, including the general properties for invariant object recognition, may explain why a subpart of the left ventral visual system, termed the visual word form area (VWFA) has been partially co-opted or recycled for recognizing the visual shapes of (alphabetic symbols) typographic fonts (Cohen et al. 2000, Heilman, 2005, Sere et al. 2007, McManus, 2002, Ullman 2007). Conversely, it is rather likely that all per-existing properties suit the new target function. In some cases, the acquisition of cultural developments may require the surmounting of properties that were useful for the original function, but are **deleteriou**s for the new one. A paradigm of such an objectionable property for typo-interpretation acquisition is ***mirror repeat image generalization*** or the ***mirror invariance*****,** namely the inclination to confuse lateral reflections.

Lateral reflection or enantiomorphism, learning's confirmed that, it is difficult for differentiating and remembering in infant's children and even adults for whom long priming (with primes and probes separated by several minutes) is unaffected by left-right reflection (Biederman and Cooper, 1991, Stankiewice et al., 1998, Fiser and Biederman,2001, Ahmed and Watila, 2017). Mirror invariance appears to have been acutely rooted by evolution into the visual system: Learning's attested that, many animals akin to octopuses, rodents, fishes and monkeys are also confused by deleterious or enantiomorphism's (Corballis and Beale, 1976) and neurons in monkeys' infertemporal cortex generalize over mirror reversal (Logothetis et al., 1995; Baylis and Driver, 2001, Rollenhagen and Olson, 2000).

Characteristically, this visual system most probably arose in the course of evolution because most natural visual categories are invariant across enantiomorphism changes (Corballis and Beale, 1976; Corballis, Hattie, Fletcher, 2008, Gross and Bornstein, 1978), and that's why, lateral reversals convey is diminutive so that one can intrinsically become a typo-interpreter.

Consistently, intrinsic adult interpreters the VWFA simultaneously characterize a maximal effect of mirror priming for pictures of logical objects, fruits and animals and an absence of mirror priming for words (Dehaene et al., 2010) and alphabets (Pegado et al., 2011). An orientation-independent task in which information about the object viewed: "a leopard is just as intimidating when viewed in right or left silhouette" (Outline drawings) (Rollenhagen and Oslon, 2000). Conversely, whereas useful for recognition of natural objects, mirror invariance is deleterious for interpreting typographic fonts (alphabet) among the Egu-yorubas in Badagry area in Nigeria/Benin Republic. As these type-fonts includes minimal mirror repeat pairs' such as ***b***, ***d, p, q*** mirror repeat generalization would impede typographic interpretation acquisition, leading to confusion between mirrored (alphabets) type-fonts. Mirror invariance is an inherent property of a subpart of the visual cortex that has thus to be unlearned or at least suppressed participants had to critic either whether a target or prime that are smaller in real-life than a standard computer screen (Dehaene et al., 2010) or whether it reside (or not) within a central frame (Pegado et al., 2011), each target being preceded by either or a different that appeared in the same orientation or mirrored repression (i.e., decreased FMRI activation due to processing subsequent stimuli with identical attributes) was observed in the VWFA only for mirrored pictures not for mirrored typo-fonts or alphabets, In addition, in Dehaene et al, (2010a) the size judgments were accelerated by mirror primes much more for pictures than for typo-fonts.

There is a substantial evidence for a progressive unlearning of mirror invariance in children at the behavioral level, and this process is crucial for multilingual materials, generalizes to non-multilingual incentive (Serpell, 1971; Casey, 1984; Gibson et al; 1962; Cronin, 1967). These developmental learning's confuses age with literacy level, leading to the view that the aptitude to differentiate mirror repeat images would mainly depend on neural maturation (Corballis and Beale, 1976; Casey, 1984). Learning's, on adults who disentangled the influence of literacy from that of neural maturation In these, more recent learning's on adults who remained illiterate (unschooled) for strictly socioeconomic reasons were far shoddier at discerning between non-multilingual enantiomorphism (of geometric shape, as well as of pictures of graspable objects like tools, furniture, clothes and utensils) than both early literate, who learned to read at school in childhood, and tardy literate who never attended school in childhood but learned to read in adulthood in special classes (adult education classes).

Interpretations', in this unlearned process may have unfavorable consequences for object recognition if objects fluctuate by orientation in a way inappropriate to the task. Persistent with this idea the priming effects by (Dehaene et al, (2010a) in the size of judgment task: for pictures of objects, behavioral priming effects were less significant for mirror repeat images than for identical primes. Correspondingly, in a behavioral orientation-independent, identity-based same-different comparison task in which participants had to respond "same" to both physically identical and mirror repeat images, Dehaene et al. (2010) accounted that, participants confirm of impediment from inappropriate mirror variations: they were quicker to respond to identical than to mirror repeat images of non-multilingual objects. Pegado et al, (2014) provided direct evidence to support the idea using analogous identity-based task, they further that, such mirror impediments are by-products of literacy acquisition: both early and tardy literate adults presented confirm responses and increased error rates when alphabet twines, false typo-fonts and pictures of graspable objects were mirrored rather than strictly identical, whereas unschooled (illiterate) adults did not present any cost for mirrored pairs.

The present learning investigates a comparative measures similar to Dehaene et al, (2010a) and Pegado et al. 2014 using an identity–based same-different comparison task on illiterate, (unschooled) tardy literate, and early literate (semi-educated): Two experiments were examined, each trial participants were queried to decide whether the second incentive (S2) was the same or not as the first one (S1), independent of its orientation.

First, this learning tartan for the specificity of the literacy effect by comparing the mirror impediment effect to the impediment caused by another orientation contrast, (rotation impediment) i.e., rotations in the image plane or plane rotations reported by (Pegado et al. 2014). As previously noted by learning's that, both mirror repeat images and plane rotations distinguishes graphic forms in the Egu-yorubas alphabet (e.g. d-b, and d-p, correspondingly). The impact of literacy on ability would thus influence discrimination of both types of orientation contrasts (Gibson et al. 1962). Hitherto, to the neuronal recycling hypothesis by Dehaene, (2009), the impact of interpretative acquisition should be dominant on enantiomorphism, as the ventral visual pathway is first and foremost sensitive to plane rotations but not to mirror repeat images (Logothetis et al., 1995). Learning's reported that, in orientation-dependent task, that there were no explicit variation bigotry for both illiterate and literate adults in plane rotations far more easily than enantiomorphism (Fernandez and Kolinsky, 2013; Kolinsky et al, 2011), It is then probable that in an identity-based task, (inappropriate) plane-rotations contrasts would be easily activated automated than (inappropriate) mirror repeat images contrasts. While, the differences might hold true for all participants, whatever their literacy level, it might be dominant for illiterates, as they display very poor enantiomorphism discrimination (Fernandez and Kolinsky, 2013) At this juncture, the learning thus envisaged that the impediment effect would be dominant with plane rotations than with mirror repeat images for all participants, and that rotation impediment would be less modulated by literacy than mirror repeat impediment, which was expected to be far dominant in literate than illiterate participants as was the case in Pegado et al.(2014).

Second, this learning tartan whether the potency of the impediment displayed by the participants would fluctuate as a function of the nature of the non-multilingual material. Transversely, in the two experiments, the learning examined the impact of comprehensibility of the material. Experiment 1, on familiar objects, the learning examined the role of grasp ability, explicitly of the degree by which vasomotor information is significant to the representation of the object, by appraising identity-based judgment for non-graspable and graspable objects: for the latter (e.g., a mallet), there is a dominant relationship between shape and technique of being grasped or manipulated.

The impact of comprehensibility of the material was examined by comparing pictures of familiar objects (Experiment 1) and (Experiment 2) on geometric shapes. The learning envisaged that, impediment from inappropriate orientation variations would be dominant with geometric shapes than with familiar objects on at most with non-graspable ones, for both mirror repeat images and plane rotations. This speculation is based on the three non-mutually exclusive reasons. First, simple geometric shapes may be similar to typo-fonts than familiar objects, and there seems to be an earlier bias in the VWFA for processing visual features of symbol-like shapes. Sustaining this idea, Szwed et al. (2011) instituted that, configurations of outline junctions, which seem universally used in writing systems worldwide (discussions in Changizi et al. 2006; Dehaene, 2014, Downey, 2014, Coltheart, 2014, Diamond, 2013, Stroet, Opdenakker, and Mumelert, 2013), specifically promote activation in the ventral coalesce form of the visual system. Since mirror repeat typo-fonts or alphabets are much more differentiated in the VWFA than mirrored pictures, if geometric shapes were treated as visual features of symbol-like shapes, then their mirror repeat images would also be more differentiated than mirrored familiar objects thus leading to a more dominant mirror impediment for geometric shapes in the identity-based task. Dispositional, to the processing of this kind of material might also illuminate that even for the preliterate, alphabetic-like shapes before now being stimulated the VWFA reported by (Cantlon et al. 2011). In addition, even adolescent brood preliterate and illiterate adults might benefit from minimal knowledge to typo-fonts and other symbols. Repeatedly, illiterate adults with some knowledge of typo-fonts (alphabetic) previously process typo-fonts differently than non-typo-fonts incentives (Fernandez et al. 2014,). Finally, learning's posit that some visual models, original shapes are not explicit in a viewpoint-dependent, orientation-specific way, whilst familiar objects (non-graspable ones) gain from viewpoint-independent, object-centered representations (Tarr and Bulthoff, 1993). The performance of illiterate adult enantiomorphic is stable with all these views: in an orientation-dependent task requiring explicit bias of mirror-repeat images, their performance was making possible for geometric shapes dissimilarity to (non-graspable) familiar objects i.e., for those which the setting of the object does not specify the use of one particular hand. This was the case for in all groups i.e., illiterate, tardy and early literate adults and perhaps reflects that orientation signals the vasomotor properties of graspable objects, for which those properties are critical but not to non-graspable ones (Murata et al., 2006; Rice et al. 2007). Within Experiment 1, the learning compared graspable to non-graspable familiar objects, envisaging that mirror impediment would be dominant with graspable than non-graspable objects.

In view of the fact that the identity judgment used in the present learning is an easy task, even for unschooled (Pegado et al. 2014), instructions accentuates both accuracy and speed, with the ultimate being the principal measure of interest. For both accuracy the respond times (RTs), the learning compared performance on physical identical trials, in which object identity and orientation were the same, to performance on different-orientation trials, in which object identity was also the same but S2 was either a mirror repeat images or a plane rotation of S1, hitherto since it is (learning's) known that illiterates have difficulties at speed responses, to which they are not use to (Ventura et al. 2007; Kolinsky et al. 2011), and since they often present quite variable performance (Kolinsky et al. 2011), this learning anticipated a display of slower and perhaps less accurate responses than literate. Managing this overall between-group difference, as reported in Pegado et al. (2014) This learning used a standardized impediment index computed, separately for mirror and for plane-rotation variation, as the RT (or accuracy) on different-orientation and identical trials. We envisaged that both tardy and early literates would present dominant impediment from inappropriate orientation variations than illiterates, particularly with enantiomorphism.

Experiment 1: Identity *Judgments* on Familiar Objects
Procedures
Participants

Fifty-five adults were progressively motivated and rewarded for their participation to a series of test, counting, orientation-dependent tasks using the same materials (see Table 1). They were accorded to their schooling and literacy stratum (see Table1), they were assigned to three group's illiterate (unschooled) tardy literate (semi-schooled) and early literate (schooled). For ethical reasons, the learning made a consent protocol to the community leaders/schools for approval; all participants were provided oral informed consent

The learning examined the *Signal Detection Theory* (SDT) *d'* statistics tailored for same-different comparison tasks (Macmilliaan and Creenlman, 2005), considering as *cuff* the correct "different" responses on trials in which both object identity and orientation were different, and as *mocked alarm* the incorrect "different" responses on identical trials, in which both object identity orientation were the same (see Figure 3 for each group) Three illiterates were ineligible from further learning for not grasping the task: they were presented a *d*' of zero, while all other participants were quite able to perform the task with mean *d*' scores of 4.37 (*SD*=1.56), 5.74 (*SD*=1.11) and 6.01 *(SD*=0.67) for illiterates, Tardy literates and early literates consistently.

TABLE 1

Table 1 Experiment 1: Mean performance in the identity-based same-different comparison Task for familiar objects, presented by object type, trial type, and group of participants

	Trial type		Graspable objects			Non-graspable objects		
	Expected response	Orientation	Illiterates	Tardy	Early literates	Illiterates	Tardy	Early literates
Accuracy (%)	Different		84.57 [13.86]	94.49 [5.83]	96.09 [4.33]	86.67 [13.71]	95.42 [5.26]	97.02 [2.83]
	Same	Identical	87.18 [10.01]	95.93 [4.56]	96.67 [3.37]	86.06 [10.81]	94.27 [7.14]	97.13 [2.53]
	Same	Mirror	86.82 [9.01]	95.47 [4.00]	96.67 [2.74]	87.18 [8.82]	95.27 [4.08]	96.40 [3.11]
	Same	Rotation	89.00 [7.78]	94.53 [5.90]	97.00 [2.17]	87.24 [10.16]	94.47 [4.60]	94.47 [3.76]
RTs (ms)	Different		1022 [243]	844 [277]	714 [129]	1031 [254]	847 [271]	709 [138]
	Same	Identical	826 [269]	677 [213]	591 [77]	828 [227]	680 [207]	607 [86]
	Same	Mirror	826 [216]	705 [230]	625 [86]	807 [195]	707 [233]	620 [79]
	Same	Rotation	837 [179]	741 [236]	641 [80]	850 [191]	752 [260]	632 [71]

Standard deviations in brackets

Graphics by Emmanuel .S. Lobo with Adobe Illustrator Cs6, 2018.

Table 1. Experiment 1: Mean performance in the identity-based same-different comparison task for familiar objects, presented by object type, trial type, and group of participants.

The final samples integrated were, 17 illiterates (11 women), aged 36-70 years (mean=56.6), 16 tardy literates (12 women), aged 27=60 years (m=49.3), and 17 early literates (8 women), aged 30-65 years (m=52.5). Illiterates were recruited through non-legislative agencies or were attending the first lesson in adult literacy classes (third week adult classes) tardy literates were engaged in fourth level of the literacy course. The three groups were from the same socioeconomic and inhabited background and had similar ages.

The participants were first all presented with alphabet recognition and interpretation (Pegado, et al, 2014) tests. Illiterates were competent to identify, on average, 8.66 alphabetic characters out of the 23 alphabets of the Egu-yoruba's alphabet, one of them was competent to interpret the alphabets (m= 0.49%). Approximately, all the tardy literates correctly identified the 23 alphabets (m=22.67) and skilled at least 83.3% correct in the interpretation tests (m=96.7%). With the exception of one participant who did not recognize one alphabet, all early literates were ideal in both the alphabet recognition (m=100%) tests. In the analyses of variance (ANOVA) on the these scores, the main effect of group was remarkable on both alphabet recognition and interpretation performance, $F_{(2.44)}$ =88.88 and =3052.46, respectively, *both p< 0001*[1]*.post-hoc test*[2] *showed that tardy and early literates adults presented the same level of* performance on alphabet recognition, both differing from illiterates, both p < 0.001. In the interpretation test, all groups are at variance from each other, p < 0.05 in all cases.

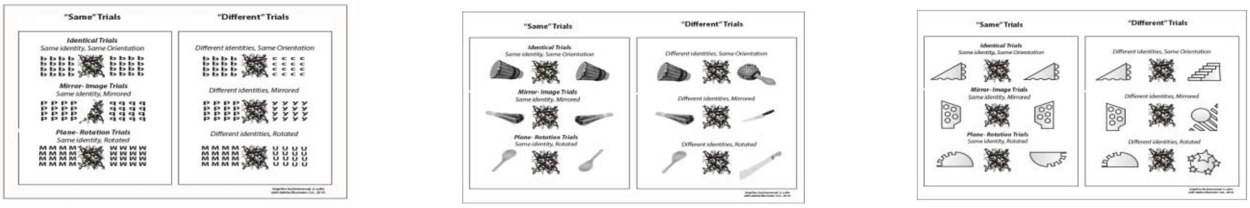
The participants were all tested with a Mini-Mental State Examination in order to appraise their prospective cognitive differences (MMSE, Flostein et al, 1975) This test is known to be susceptible to educational and (allied) literacy level (see, Crum et al, 1993, Leganlt, and Indicht, 2013), this learning used MMSE revised scores, recalculate individual scores after discarding the items that examine interpretation, typo-characters, and reckoning abilities. This led to comparable mean scores of 24.47 (*SD=3.02*), 23.47 *(SD=1.77*), and 23.33 (*SD=1.68*) by illiterates, tardy literates and early literates respectively, F< 1.[1]

Subsequent to the orientation-independent tasks presented at this juncture, 38 participants (11 illiterates 14 tardy literates and 13 early literates were also tested on orientation-dependent tasks using either pictures of familiar objects or geometric shapes akin to (Fernandez and Kolinsky, et al, 2013). In the orientation-dependent task, the illiterates who were presented with both types of tasks showed difficulties particularly in discerning mirror repeat images, attained 64.8% correct on "different" trials involving mirror repeat images (64.17% for familiar objects, 65.5% for geometric shapes) opposed to more than 80% correct on "different" trials involving plane rotations on (82.1% for familiar objects, 80.3% for geometric shapes) and more than 85% correct on "same" trials 85.8% for familiar objects, 86.8% for geometric shapes)

Procedure and Materials

The materials used as incentives (stimuli) were black and white pictures of asymmetric objects. As akin to Fernandez and Kolinsky (2013), most were (Africanized) illustrated by Emmanuel (2018), Examples are presented in Figure 1.

Figure 1: Examples of the stimuli used in the "same" and "different" trials of Experiment 1.



The significant trials are the three types of "same" trials.

A total of 36 different objects were used, half being graspable, the others non-graspable, as appraised by an independent group of participants (see Appendix Emmanuel, (2018) akin illustration to Fernandez and Kolinsky, 2013)

In favor of each object, a standard position, parallel always to S1, was apparent, and for the S2 a mirror repeat image (lateral reflection) as well as plane rotation were created, both differing from the standard by 1700

Each trial started with a fixation cross presented in the center of a (card board framed) screen for 250ms, after which S1 was presented during 2000ms, then a 500ms, mask comprising random lines separated the presentation of S2 from the presentation S1 in order to guarantee no involvement of iconic memory in performance. On each trial, participants were asked to decide as swiftly and as accurately as possible whether the second object was the same or not as the first, independently of its orientation. They hence had to answer "same" if S2 had the same identity as S1, independently of whether it had the same orientation (identical trials) or not, and to answer "different" if S2 had a different identity contrast to S1, as well independently of their orientation. As illustrated in Figure 1, on different orientation trials, S2 could be either mirrored or plane-rotation version of S1. RT$_S$ were measured from the beginning of S2 to response onset. Instantaneously after participants gave their response another trial set in motion, or if no response was provided the next trial commence after 4750ms.

Participants were presented with eight hundred and sixty-two (862) trials, half "same" half "different". Each of the six credible used for an exact object (see Figure 1) was presented twice, in different blocks. Participants were first presented with six practice trials to familiarize them with the task. They acknowledged criticism on the correctness of their response only for these trials.

Results

Learning's were independently carried out on accuracy and RT$_S$ correct responses. For each participant, correct RT$_S$ longer or shorter than the grandiose mean plus or less 2.5 SD were isolated from further analyses (less than 3% of the data excluded). In all analyses, RT$_S$ for correct response were logarithmically transformed and accuracy was arsine transformed[4]. For the sake of clarity, tables and figures present RT$_S$ in MS and accuracy in percentages.

Table 1 presents the mean scores for all trials types, independently for each group. Only the trials in which object identity was the same were measured in the following analyses. For both RT$_S$ and accuracy, this learning compared performance on physical identical trials to performance on trials in which object identity was also the same but where S2 was either a mirror repeat images or a plane rotation S1.

The learning performed two independent ANOVAS in the first rung, one on RT$_S$, the other on accuracy, each with group (illiterates; tardy literates; early literates) as a between-participants' variable and orientation (identical; mirror; rotation) and grasp ability (graspable vs. non-graspable objects) as within-participants variables.

There was a main effect of group for both RT$_S$ $F_{(2.44)} = 6.79$, $p = 0.003$, $n^2 p = 0.236$, and accuracy, $F_{(2.44)} =$ 11 .16, $p < 0.001$, $n^2 p = 0.337$. *Post-hoc* contrast confirmed that illiterates were notably less accurate and slower than early literates, both $p < 0.005$, and less accurate, p – 0.003, but not slower, p = 0. 10, than tardy literates, while tardy literates and early literates did not fluctuate from each other in either investigation, both $p = 0.30$.

There was also no noteworthy effect found in the accuracy analyses, all other $F < 1$, including the main effects of orientation and grasp ability, and the orientation by group interaction. Grasp ability did not affect performance on RTs either, $F < 1$.

Hitherto, orientation strongly affected performance in the RTs investigation, $\mathbf{F}_{(2.88)} = 27.31$, $p < 0.001$, $n^2\ p = 0.389$, in which it's modulated by group, $F_{(4.88)}$, $p = 2.48$, $p < 0.101$. Orientation of the incentives (stimulus) strongly affected the response speed of both tardy literates, $F_{(2.28)} = 35.27$, $p < 0.001$, $n^2\ p = 9{,}716$, and early literates adults, $F_{(2.28)}\ p = 13.48$, $p < 0.001$, $n^2\ p = 490$. Contractually, it only slightly and non-significantly modulated the illiterates' response latencies $F_{(2.32)} = 2.35$, $p < 0.11$, $n^2\ p = 0.111$. Where illiterate's responses to mirror trials were as fast as those to identical trials, $F < 1$, in the two literates groups, performance was slower for mirror repeat images contrast to identical trials [tardy literates: $F_{(1.28)} = 9.83$, $p = 0.004$; early literates $F_{(10.56)} = 0.003$]. In favor of rotations, all the groups presented slower responses contrast to both identical trials [illiterates: $F_{(1.44)} = 15.32$, $p < 0.005$; tardy literates: $F(1.28) = 32.26$, $p < 0.001$; early literates $F_{(1.28)} = 6.15$, $p < 0.019$].

The performance of grasp ability was not accounted for in the analyses of impediment index, as this aspect did not affect performance showed, in addition, that illiterates were less susceptible to inappropriate orientation variation than literates for both mirror repeat images and (although to lesser extent) for rotations. As illustrated in Figure 2, on the RTs impediment index, only illiterates were unaffected by orientation variations, with both mirror impediment and rotation impediment not differing form zero, $t < 1$ and $t_{(14)} = 1.39$, $p = 0.18$, respectively. In contrast, both literates groups presented significant mirror impediment [tardy literates: $t_{(14)} = 3.00$, $p = 0.009$; early literates: $t_{(14)} = 5.16$, $p < 0.001$]. On the accuracy impediment index, only early literates showed significant rotation impediment, $t_{(14)} = 2.33$, $p = 0.\ 034$, all other $= p < 0.02$.

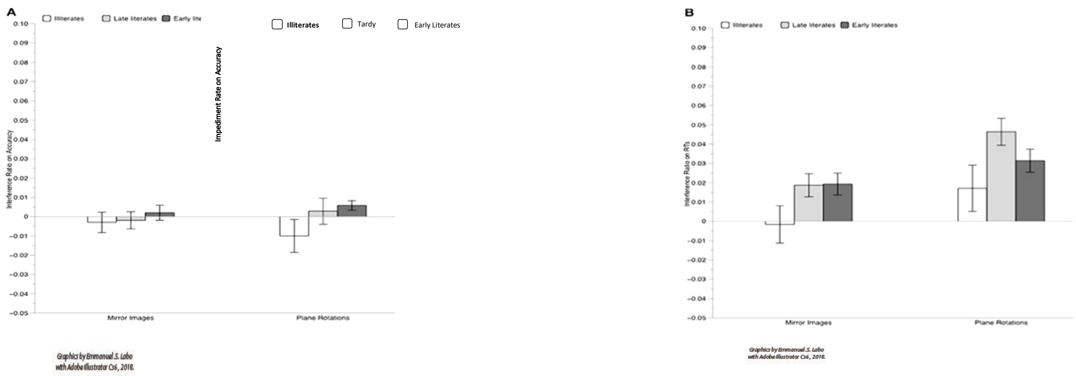


Figure 2: Mean value of the impediment index for familiar objects, computed on accuracy scores (Panel A) and on RTs (Panel B), separately for each group of participants. Error bars represent standard error of the mean.

As the size of impediment was similar for tardy literates and early literates for both mirror repeat images, $t < 1$, and plane rotations, $t_{(28)} = 1.61$, $p = 0.12$, this learning contrasted the illiterate group to these literate participants. Contrastively, illiterate adults clearly presented weaker mirror impediment $t_{(45)} = -2.27$, $p = 0.028$, and rather weaker rotation impediment, $t_{(45)} = -1.96$, $p = 0.\ o56$.

Discussion

Replicate to previous learning's (Dehaene et al., 2010a; Pegado et al., 2011; Fernandez and Kolinsky, 2013), this learning demonstrated that in adult interpretive enantiomorphism is automatically induced during object recognition. In addition, substantiating the results accounted by Pegado et al. (2014), the learning showed that this process is a corollary of literacy acquisition: in an identity-based same different comparison task in which participants had to respond "same" to both physically identical and different oriented pictures of the same object, only literates but not illiterate adults were affected by in appropriate enantiomorphic variations. Therefore, in literates, flouting mirror invariance impediment with non-multilingual objects recognition task when orientation is neither relevant nor useful for it.

Furthermore, as predicted by the neuronal recycling hypothesis (Dehaene and Cohen, 2007; Dehaene, 2009), rotations impediment was dominant than mirror impediment, at least in the literates. Mirror repeat images thus remain less silent or less automatically induced than plane rotations when processing the identity of familiar objects probably because enantiomorphism is learned in the course of literacy acquisition. Contradictory, to the prediction, no effect grasp ability was observed.

Experiment 2 Identity Judgment on Geometric Shapes
Procedure
Participants

Amongst the participants of Experiment 1, 46 participated in this experiment: 17 illiterates, and all the tardy and early literates'. The learning tartan for task commitment, examining the SDT d' scores in the same-different comparison task. One illiterate who presented a d'-o was excluded from further analyses. All other participants were able to acceptably perform the task with mean d' scores of 3.95 (SD = 1.93), 4.92 (SD) = 0.99, and 5.17 (SD0 = 0.92) by illiterates, tardy and early literates respectively.

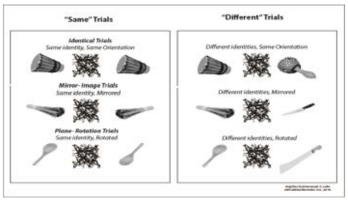
The final illiterate trial thus included 15 participants (9 women), aged 32-65 years (M = 56.0). They were able to identify, on average, 8.2 alphabets of the Egu-yorubas, and a diminutive number were able to interpret a type-font (type-characters) of the interpretive test. Their mean revised MMSE scores were 23.80 (SD: 3.14 same scores as the unrevised one).

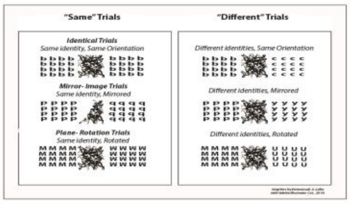
Procedure and Material

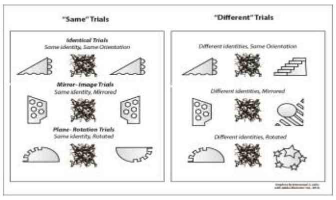
Nine asymmetric geometric shapes were used (see in Figure 3)

FIGURE 3

Figure 1: Examples of the stimuli used in the "same" and "different" trials of Experiment 1.







The significant trials are the three types "same" trials.

Modified graphic (Emmanuel, 2018) of the pairs and the trials types were identical to Experiment 1 (see Figure 3). Participants were presented with a total of 216 trials, half "same" half "different." Each incentive (stimulus) S1 shape was paired four times with replica and four times with mirror repeat images and its plane rotation. For "different" trials, each S1 shape was paired four times with a different geometric shape, with a mirror repeat images, and with a plane rotation of that shape. Procedure was the same as in Experiment 1.

Results

Statistics were tidied (< 3% of data excluded) and analyzed as in Experiment 1. Table 2 presents the mean scores for all trials types, separately for each group.

TABLE 2

	Trial type		Graspable objects			Non-graspable objects		
	Expected response	Orientation	Illiterates	Tardy	Early literates	Illiterates	Tardy	Early literates
Accuracy (%)	Different		84.57 [13.86]	94.49 [5.83]	96.09 [4.33]	86.67 [13.71]	95.42 [5.26]	97.02 [2.83]
	Same	Identical	87.18 [10.01]	95.93 [4.56]	96.67 [3.37]	86.06 [10.81]	94.27 [7.14]	97.13 [2.53]
	Same	Mirror	86.82 [9.01]	95.47 [4.00]	96.67 [2.74]	87.18 [8.82]	95.27 [4.08]	96.40 [3.11]
	Same	Rotation	89.00 [7.78]	94.53 [5.90]	97.00 [2.17]	87.24 [10.16]	94.47 [4.60]	94.47 [3.76]
RTs (ms)	Different		1022 [243]	844 [277]	714 [129]	1031 [254]	847 [271]	709 [138]
	Same	Identical	826 [269]	677 [213]	591 [77]	828 [227]	680 [207]	607 [86]
	Same	Mirror	826 [216]	705 [230]	625 [86]	807 [195]	707 [233]	620 [79]
	Same	Rotation	837 [179]	741 [236]	641 [80]	850 [191]	752 [260]	632 [71]

Standard deviations in brackets

Graphics by Emmanuel .S. Labo with Adobe Illustrator Cs6, 2018.

Table 1. Experiment 1: Mean performance in the identity-based same-different comparison task for familiar objects, presented by object type, trial type, and group of participants.

On accuracy ANOVA, only the main effect of the orientation was significant, $F_{(2, 84)} = 14.83$, $p < 0.01$, n2 p = 0.261, with identical trials leading to better performance than both mirror repeat images, $F_{(1, 42)} = 12.43$, and rotations, $F_{(1, 42)} = 25.59$, both p = 0 < 0.001 (mirror images vs. rotations: F = 3.79. p =0.058). The group effect only predisposed toward significant, F = 1.2, the learning further examined the effect of orientation on performance on each group, in view of both the results of Experiment 1 and prior results on literate participants showing that they are more sensitive to orientation variations than illiterates (Pegado et al., 2014). Justifiably, effect of orientation was found in illiterates, $F_{(2.28)} = 1.76$, p = 0.19, the effect of orientation was significant for both tardy literates, and early literates, $F_{(2.28)} = 9.17$, $p < 0.001$. In the two literate groups proportional to identical trials, performance was shoddier for mirror repeat images [tardy literates: $F_{(1, 14)} = 5.32 = 0.036$; early literates, $F_{(1, 14)} = 10.36$, p = 0.001]. Consistently, the analyses of the accuracy impediment indexes (see Figure 4A) showed that only the literates were reprimanded by orientation variations, with significant mirror impediment [tardy literates: $t_{(14)} = 2.22$, $p = 0.043$; early literates: $t_{(14)} = 2.14$, $p = 0.049$] and rotation impediment [tardy literates: $t_{(14)} = 2.77$, $p = 0.015$; early literates: $t_{(14)} = 2.94$, $p = 0.010$]. In contrast, illiterates exhibited no mirror repeat impediment, $t < 1$, nor rotation impediment, $t_{(14)} = 1.40$, $p = 0.18$. Since the amount of mirror and rotation impediment was similar for tardy and early literates, both $t < 1$, the learning tested whether illiterates presented weaker impediment than the literates' participants. This was the case for mirror impediment, $t_{(42)} = - 1.80$, $p = 0.038$, but for rotation impediment, $t_{(42)} = - 1.18$, $p = - 0.122$.

FIGURE 4

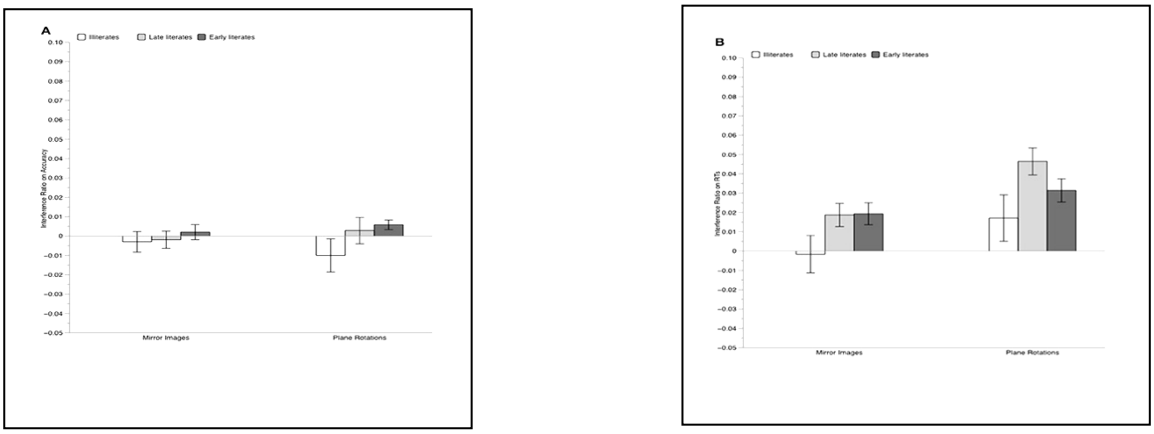


Figure 4. Mean value of the impediment index for geometric shapes, computed on accuracy scores (Panel A) and on RTS (Panel B), separately for each group of participants. Error bars represent standard error of the mean

Hitherto, the RTS analyses suggested that even illiterates were to some extent sensitive to inappropriate mirror repeat images of geometric shapes: both the main effect of group, $F_{(2.42)} = 5.01$, $p = 0.01$, n2 p = 0.193 (with illiterates overall slower than tardy and early literates, p < o.05, and p = 0. 01, correspondingly), and of orientation, $F_{(2.84)} = 26.8$, $p < 0.001$, n^2 p = 0.389, were significant, but not their relativities, $F < 1$. Contrary to what was pragmatic on accuracy, the effect of the orientation was significant, in all groups [illiterates: $F_{(2.28)} = 4.56$, $p = 0.02$; tardy literates: $F_{(2.28)} = 14.45$, $p = 0.01$; early literates: $F_{(2.28)} = 24.83$, $p < 0.001$]. Transverse group, performance was the slowest for rotations contrast to identical trials, $F^{(1.42)} = 36.54$, and to mirror repeat images, $F_{(1.42)} = 13.14$, both ps < 0,001, and was also slower for mirror repeat images than for identical trials $F_{(1.42)} = 24.81$, $p < 0.001$. Consequently, in terms of latency both illiterates and literates participants exhibited mirrored and rotations impediment. The same conclusion can be drawn from the analyses of the RTS impediment index: as illustrated in Figure 4B, mirror and rotation impediment effects were significant in all groups (all $p < 0.03$). No difference between illiterates and literates participants was experiential, neither for mirror impediment, $t_{(43)} = - 0.25$, $p = 0.803$.

Discussion and Cross-Experiments Examination

Contrary to what was experiential in experiment 1 with familiar objects, here with geometric shapes all participants, whatever their literacy level, sensitive to the inappropriate orientation variations, at least on response latencies and mostly for plane rotations

To tartan for sturdiness of this material difference, the learning performed cross-experiment analyses on the accuracy and RTS impediment indexes of 43 participants (13 illiterates 15 tardy literates 15 early literates) who were presented with materials and sufficiently performed the identity-based task. There was a significant main effect of material in both analyses, accuracy, F(1, 40) = 10.31, p = 0. 003, n2 p = 0. 205, RT, F (1, 40) = 8.38, p = 0.006, n2 p = 0.173, with generally dominant impediment orientation effect with geometric shapes than with familiar objects. The main effect of orientation was also significant in analyses, accuracy, F (1, 40) p = 7.04, p = 0.01, n2 p = 0.150, and RT, F (1.40) = 24. 42, p < 0.01, n2 p = 0.379, with basically dominant orientation than mirror impediment. The interaction between material and orientation was only significant in accuracy, F (1, 40) = 7.68, p = 0. 008, n2 p = 0. 16, not on RTS, F < 1: rotation impediment was dominant with geometric shapes than with familiar objects, F (1, 40) = 17 .64, p < 0.001, whereas mirror repeat impediment was similar with both materials, F (1, 40) = 1. 77, p = 0. 191. In neither analysis did group interact with any other factor, all ps. > 0.10. Thus, the comparisons to familiar objects, identity-based judgments on geometric shapes were more dominantly affected by inappropriate plane orientation, whatever the literacy level of the participants.

Given that 36 participants of the present learning had also performed orientation–dependent task akin to materials (Fernandez and Kolinsky, 2013), this learning examined whether there was any association between the impediment effects reported and the performance level observed for either for mirrored or rotated trials in the orientation-dependent task akin to Fernandez and Kolinsky (2013). Transversely in materials, no correlation was observed between this performance and the RT impediment index, all rs < 0.195, ps > 0.24, but when accuracy was measured, there was a significant correlation between enantiomorphism performance and mirror impediment r (36) = 0.387, p = 0.016, but not between enantiomorphic performance and mirror impediment, r (36) = - 0.176, p = 0.289. Thus, the better the participants discriminated mirror repeat images, the stronger these impedes on their identity-based judgments.

General Discussion

Literacy is an acculturation processes that facilitate massive cognitive gains. Although, according to the neuronal recycling hypothesis (Dehaene and Cohen, 2007; Dehaene, 2009), this novel cultural ability could vie with evolutionary older functions, leading to documentation effects. As a matter of fact, enantimorphy, is the ability to differentiate between mirror repeat images that develops through interpretive acquisition (Kolinsky et al, 2011; Kolinsky and Verhaenpghe; 2011; Fernandez and Kolinsky, 2013), hurtle with the original mirror invariance property of ventral visual system. Hence, in the present learning we investigated whether enantimorphy impedes with object identity judgments, as suggested by preceding work of (Dehaene et al., 2010; Pegado et al., 2011, 2014). The learning, examined whether the expected mirror impediment reflects an explicit impact of literacy on enantiomorphism rather than a general impact on orientation processing during object recognition. Besides, the learning tartan whether the dominance of the impediment exhibited by illiterates and literates adults would be attuned by the familiarity of the material and, for familiar objects, by grasp ability (Fernandez and Kolinsky 2013). To these aims the learning presented illiterates, tardy literates (who learned to interpret at adult age) and early adults with an identity-based same-different comparison task in which they had to respond “same” to physically identical, mirrored, and plane-rotated images of whichever pictures of familiar objects (Experiment 1) or geometric shapes (Experiment 2) The learning also examined impediment form the perspectives of inappropriate orientation variations separately for mirror images and plane rotations.

Through pictures of familiar objects, differing to literates adults, illiterates did not exhibit any mirror repeat images impediment. As anticipated, for all groups, impediment was dominant with geometric shapes than with familiar objects. With geometric shapes, both plane rotations and enantiomorphic variations affected responses latencies Irrespective of the participant’s literacy level. In terms of accuracy, contrary to literates, illiterates did not exhibit mirror repeat images impediment with geometric shapes while they did show impediment.

In regards to familiar objects’ grasp ability, namely the extent by which vasomotor information is critical to the presentation of object, in contrast to this learning guesses, this property had no impact on identity-based judgments. This result pattern posits in sharp contrast to that found by Fernandez and Kolinsky (2013) in an orientation-dependent task. There, the explicit discrimination of orientation variation, either mirror repeat images or plane rotations, was fascinated for graspable objects.

Note, conversely, that the orientation variations that could have invoked action-related information of graspable objects were in the present learning immaterial to the task. Prior learning’s have confirmed that vasomotor properties of objects are particularly processed by the dorsal, vision-action stream (Valyear et al., 2006; Rice et al., 2007). In particular, parietal regions, part of the dorsal stream, have been shown to be critical for processing spatial attributes of objects in orientation-based task, but not their identity (Harris et al., 2007) Consequently, both ventral and dorsal streams operate concurrently during visual processing, their comparative involvement depends on the specific task. Task specifications might thus explain the apparent inconsistency between the grasp ability effects found in the orientation-based task used akin to Fernandez and Kolinsky and their absence in the identity-based task of this learning. Further brain-imaging learning’s could test this option.

Importantly, the result pattern is in line with prior learning’s showing that the discrimination of mirror repeat images and plane rotations are sustained by at least partially different modus operandi, and that the ventral visual pathway is originally sensitive to plane rotations but not to mirror repeat images (Logotheis and Pauls, 1995; Turnbull and McCarthy,1997; Turnbull et al., 1997). In this stratum and in line with the learning guesses, transverse groups and experiments, plane rotations impede more on identity judgments than mirror repeat images. Moreover, it was only for mirror repeat images that the size of the impediment effect was linked to the participant’s enantiormorphic performance in an orientation-dependent task (Fernandez and Kolinsky, 2013): the better they could discriminate mirror repeat images, the dominant the mirror impediment on their identity-based judgments.

Unlearning the procedure of mirror invariance, requisite to acquire literacy in the Egu-yoruba’s alphabet, has thus a cost for object identification, a basic function of the visual ventral stream. The knowledge of a negative side effect of literacy-related ability, explicitly enantiomorphy, was expected under the neuronal recycling hypothesis (Dehaene and Cohen, 2007), which implies that interpretation, as other current cultural inventions, capitalizes on evolutionary older functions, with which they might compete. Brain-imaging statistics had already shown that literacy induces a thoughtful reorganization of the cortical networks for vision and language, and that this process involves competition for neural space in the left fusiform gyrus, especially between printed strings and faces (Dehaene et al., 2010b; Ahmed and Watila, 2018).

Purportedly, a functional cost is expected here, if some properties that were useful for the original function are deleterious for the new function (interpretation) but harm the older one. Effects of both neural competition (Dehaene et al., 2010b) and functional competition as shown here, as well as by Dehaene et al., (2010a) and Pegado et al., (2011, 2014), consequently exhibit that neural recycling is not just an alteration to flexible-use but a process of at least partial exaptation (Junge and Dennjet, 2010). Generally, as noted by Dehaene et al., (2013), the presence of mirror invariance prior to the literacy and its reduction during interpretation acquisition shows that learning to interpret involves the recycling of a preexisting circuit that did not evolved wittingly for interpretation.

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