Interaction maximization as an evolution principle for social systems

Part II: What are the effects of increased interaction?

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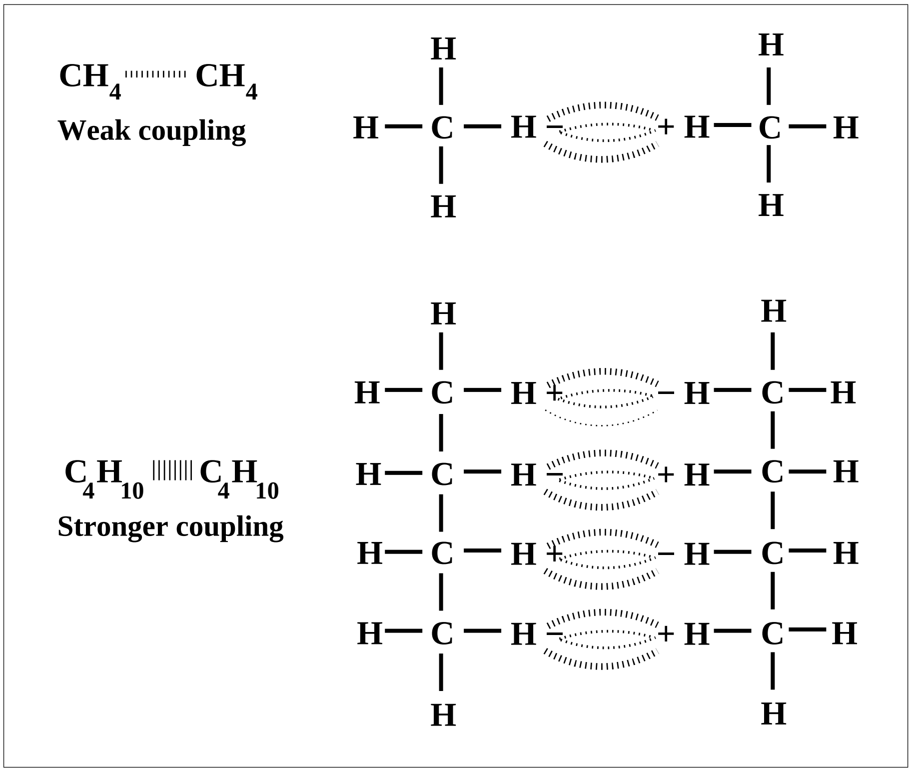
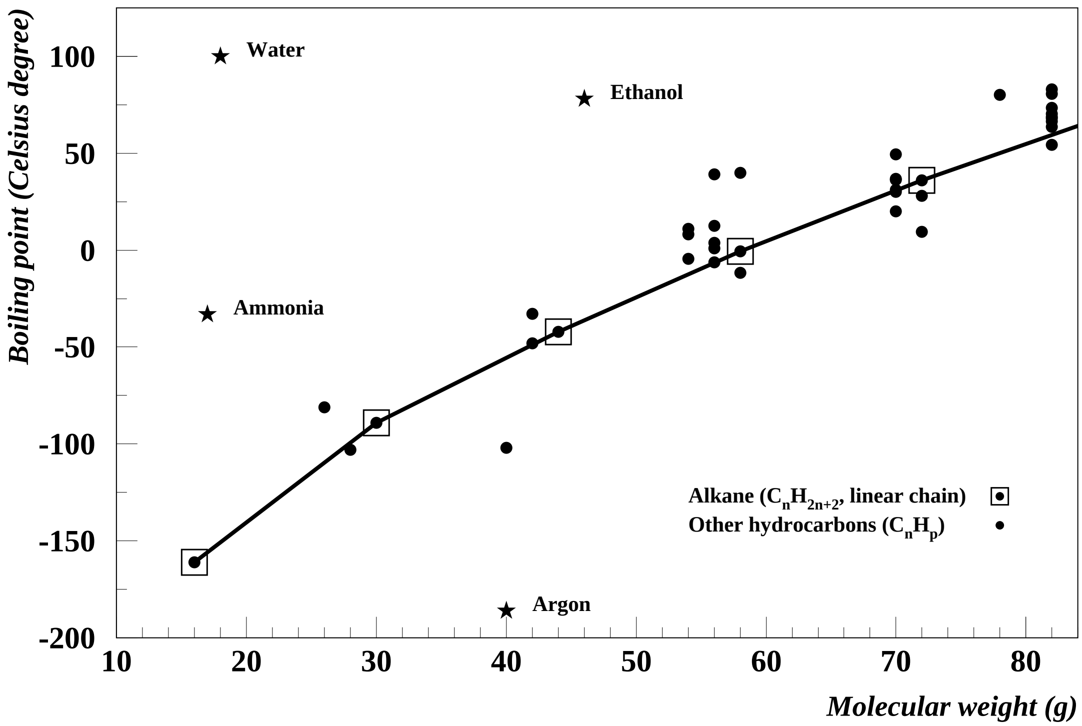
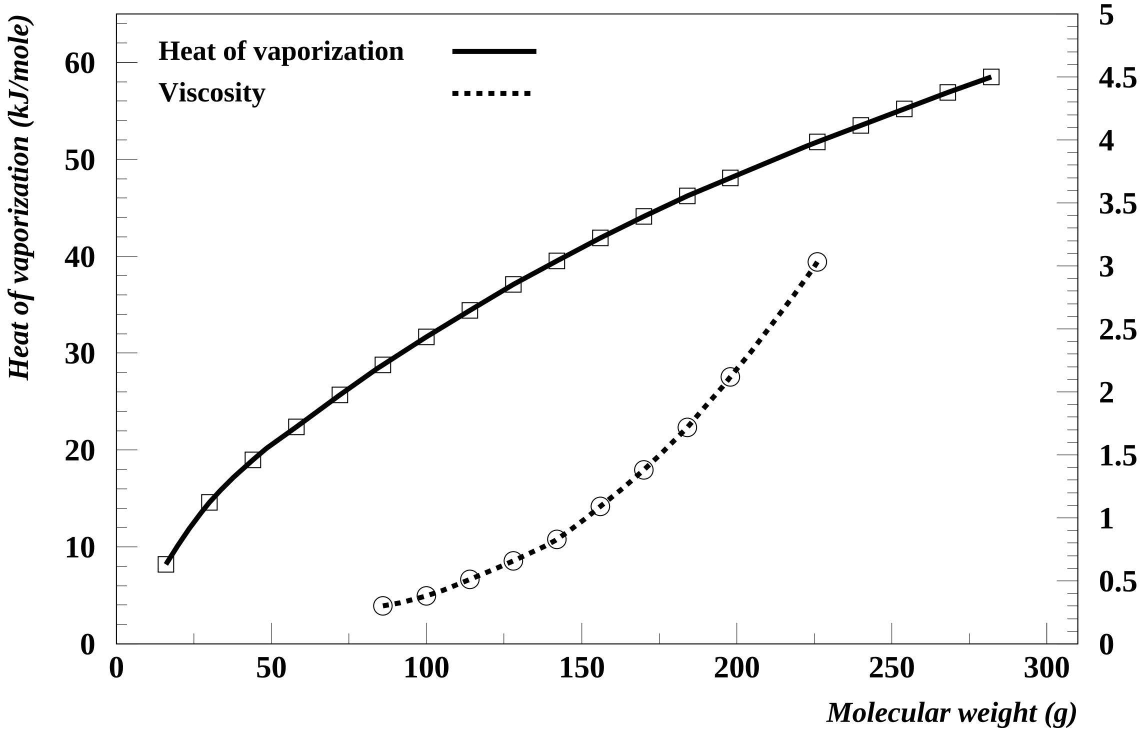
- **Increased interaction ⇒ production of heat + contraction**
- **Molecular interpretation**



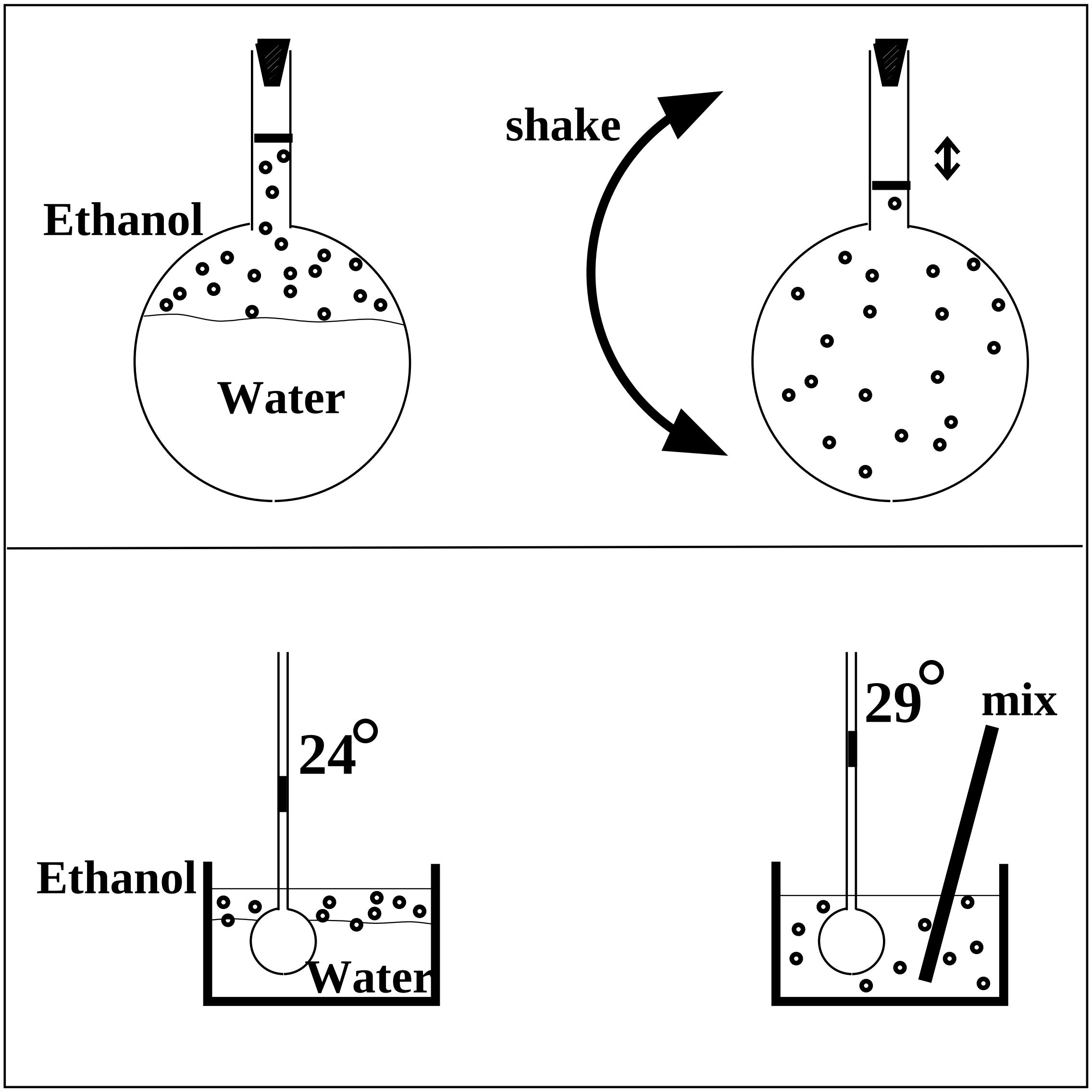
Attraction between alkane molecules.
The figure shows two alkanes: methane (CH_4) and butane (C_4H_{10}) The attraction due to induced dipoles (also called London bonds) represented in the figure is a form of interaction which is common to all molecules but besides this mode most molecules have several other modes of interaction. The particularity and simplicity of the alkanes comes from the fact that they do not have other modes of interaction. This is the reason why the attraction between two alkane molecules is proportional to the number of their hydrogen atoms $2n+2$ and thus to their molecular weight $14n+2$.



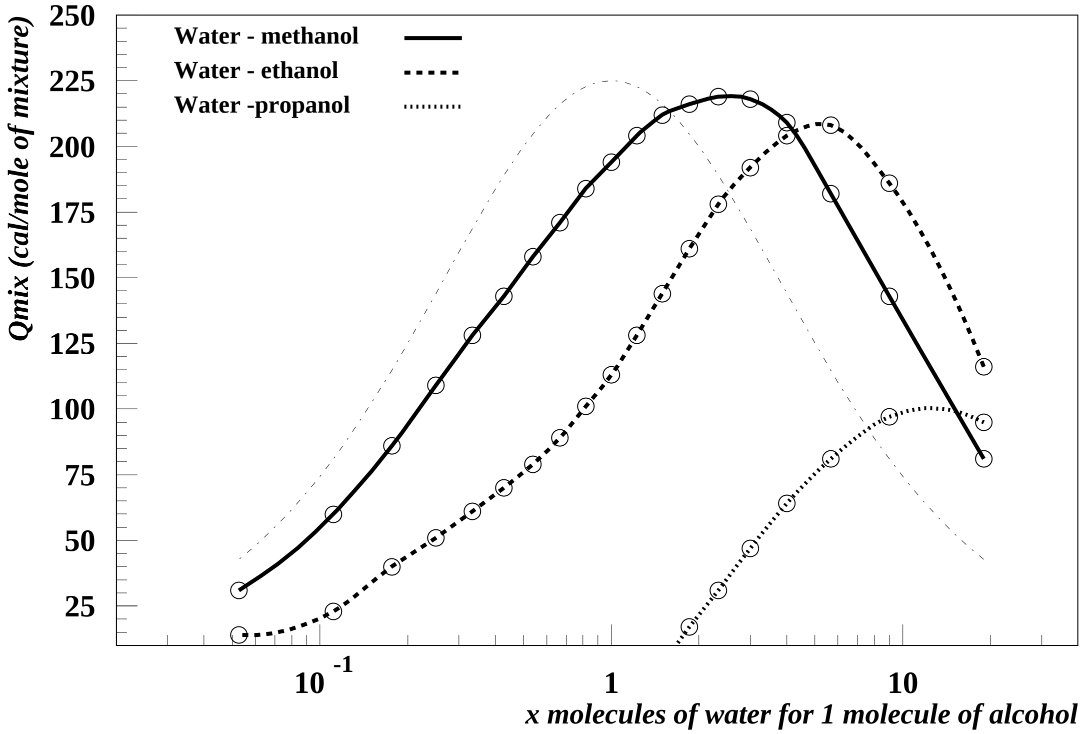
Boiling temperature as a function of intermolecular attraction. For alkanes C_nH_{2n+2} with a linear chain, which are represented by dots surrounded by a square, the inter-molecular attraction is proportional to the number of the hydrogen atoms and hence also to the molecular weight $M = 14n + 2$. The trend portrayed by the solid line means that for longer carbon chains more thermal agitation is required in order to break the intermolecular bonds. The dots represent hydrocarbons C_nH_p whose intermolecular forces, are slightly different due for instance to branched carbon chain which results in boiling temperature differences of the order of 10%. The stars correspond to compounds whose molecular coupling are of a different nature, either much weaker (argon) or much stronger (ammonia, ethanol, water).
Source: Lide (2001).



Latent heat of vaporization and viscosity as a function of intermolecular attraction for alkanes.
As explained in Fig.1a, there is a direct relationship between attraction strength and molecular weight. The solid line corresponds to the 20 first alkanes (except $n = 15$ which is missing in data tables); it describes the empirical relationship: $L_s(\mathrm{C}_n\mathrm{H}_{2n+2}) = 1.1 + 1.7n$. The broken line represents the viscosity; it is restricted to the alkanes which are liquid at room temperature, namely $n = 7, \ldots, 16$ ($n = 15$ is again missing).
Sources: Lide (2001), Moelwyn-Hughes (1961, p.702).

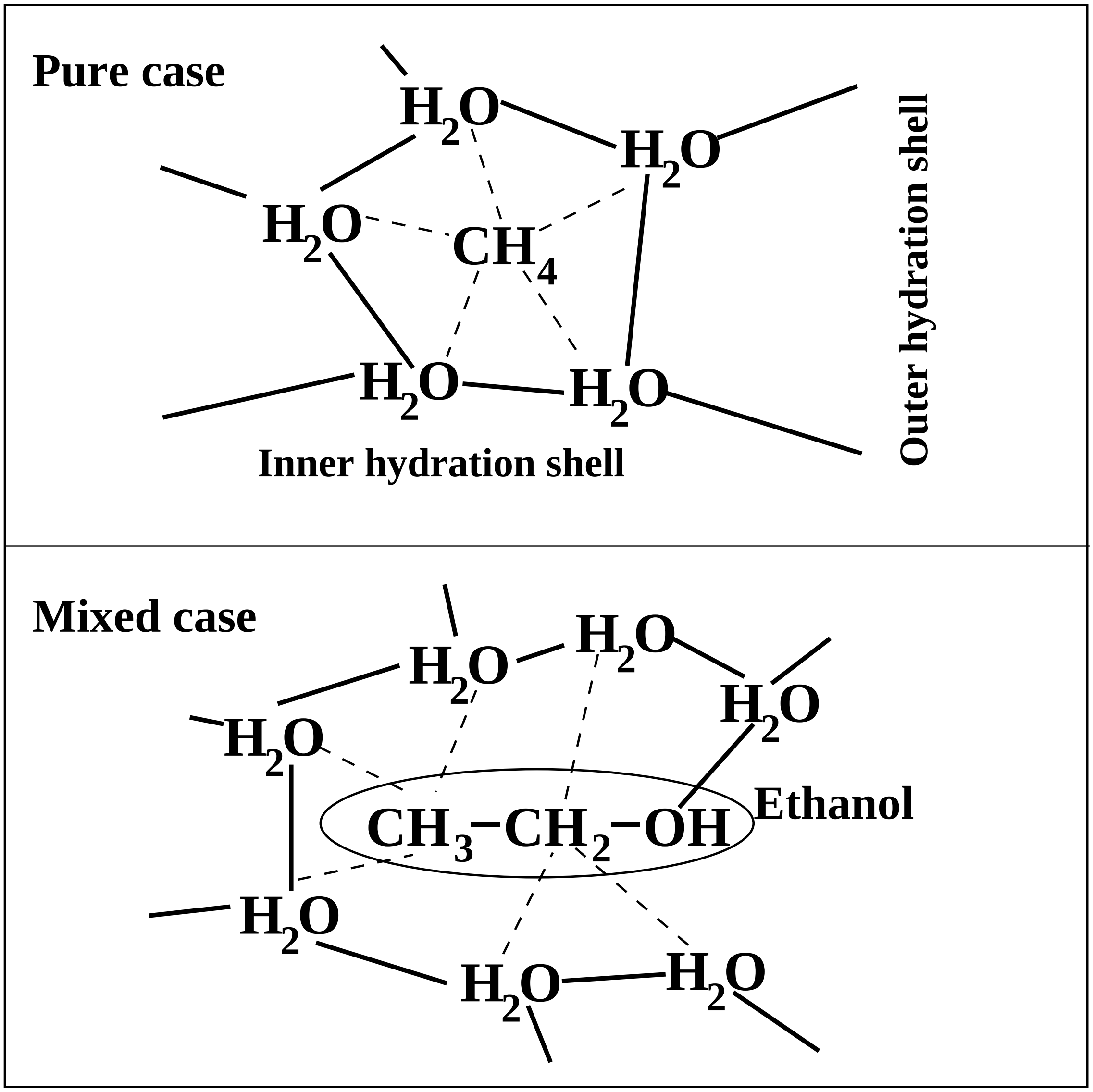


Two experiments on the mixing of water and ethanol.
Not just for fun ... These are not *Gedanken* experiments, they can be performed easily by anyone who wants to get a more intuitive feeling of the mechanisms described here. When ethanol is added to water there is a volume contraction and a release of heat. Both phenomena are affected by respective proportion and by initial temperature. As predicted by LeChatelier's principle, the effect of a temperature decrease is to increase the heat of mixing.
Similar experiments can be performed with many compounds. The mixing of acetone (C_3H_6O) and chloroform ($CHCl_3$) is even more exothermic, whereas the mixing of acetone with carbon disulphide (CS_2) is strongly endothermic and results in a volume increase. Note that because carbon disulphide is more toxic and dangerous to handle (it catches fire very easily) than the previous compounds, the last experiment should rather be done in a chemistry lab.
Source: Moelwyn-Hughes (1961, p. 812).



Heats of mixing: water - alcohols.
Methanol, ethanol and propanol are the first three alcohols: $C_nH_{2n+1}OH,\ n = 1, 2, 3$. Usually, for instance for acetone-chloroform or methanol-ethanol, the corresponding curves are symmetrical with respect to molar concentration (as indicated by the thin line curve); this points to a a connection between the shape of the curves and the structure of molecular assemblages: the dissymmetry shows that several water molecules surround each alcohol molecule. Note that when the proportion of water becomes too small, the mixing with propanol becomes endothermic.

Source: Bose (1907), Landolt-Börnstein (1976)..



Schematic representation of the molecular assemblage in water-methane and water-ethanol solutions.
In contrast to methane CH_4 which features only weak London dispersion forces, the molecule of ethanol comprises two segments (i) the alkane-like segment $CH_3 - CH_2$ (ii) the water-like end OH. For that reason, ethanol displays a dual behavior: like methane, it attracts an hydration shell of water and like water it forms strong hydrogen bonds. According to some recent studies (Dill et al. 2003, p. 581) there may be as many as 17 water molecules in the first hydration shell. The precise shape of the molecular assemblage is of little importance for the purpose of this paper; what matters is the fact that there is a highly ordered rearrangement which results in a decrease of entropy, in contrast to the standard entropy increase in the mixing of two ideal liquids.

Sources: Baumert et al (2003), Dill et al. (2003), Dixit et al. (2002), Guo et al. (2003), Israelachvili et al. (1996).

When a molecule of water is introduced among ethanol molecules it is able to establish links with them that are stronger than the interaction between ethanol molecules.
This is why the water molecule is "accepted" among ethanol molecules.

Are there similar mechanisms in social systems?
Would you see some examples?

Here is an illustration of "miscibility" in social systems

Let's consider the question: to what extent are languages "miscible"?

First, observe that a language is a system in which words or characters interact according to specific rules.

In this perspective one has the following parallels:

- words <--> molecules in a liquid,
- rules through which different words are connected to one another to form sentences <--> molecular interactions.

Now, what happens when a word (or expression) from a language A is immersed into a language B?

- if it develops enough links with other words it will be integrated.
  e.g. "week-end","ciao" are words that are commonly used in French
- if not, it will eventually drop out.
  e.g. "railway" was commonly used in the late 19th century, but for some reason, it didn't become integrated and was replaced by "chemin de fer" or "train".

Question

Are there foreign expressions which, similarly, were replaced after a while by Chinese expressions in place of phonetic transcriptions?