Synthesis of γ-Amino- and δ-Amino-Functionalised Ethers, Amines, or Silanes by Hydroaminomethylation of Heterofunctionalised Allylic Compounds

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Heterofunctionalised allylic ethers **1**, silanes **5**, and amines **9** are hydroformylated in the presence of primary or secondary amines **2** to form the corresponding γ-amino- and δ-amino-functionalised compounds. The rhodium(I)-catalysed reaction sequence proceeds by aldehyde formation and subsequent reductive amination to generate the corresponding functionalised secondary or tertiary amines. This selective one-pot hydroaminomethylation procedure establishes access to γ-amino- and δ-amino-functionalised ethers, amines or silanes with potential biological activity.

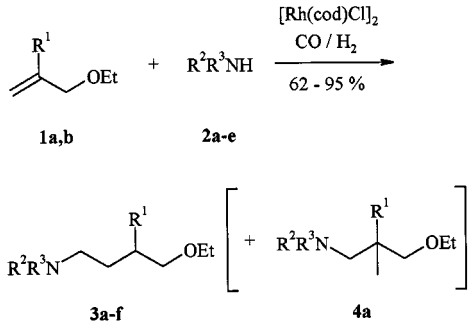
Introduction

Amines bearing additional ether, silane, or amine functions in the γ- or δ-position play an important role as antidepressants,[1] neurotropics,[1] as potential antipsychotics,[2] and as substances with antiplatelet[3] or antimicrobial[4] effects. Various methodologies towards their synthesis have been developed usually starting from 1,3- or 1,4-difunctionalised precursors.[1−5] Alternatively, these compounds may also be constructed by hydroformylation and reductive amination starting from functionalised allylic ethers, amines, or silanes. We recently reported[6] that the one-pot hydroaminomethylation[7] reaction is a convienent and efficient method for selective preparation of secondary and tertiary amines. We now report the use of this procedure to convert heterofunctionalised allylic compounds under hydroformylation conditions in the presence of a rhodium(I) catalyst and primary or secondary amines into the corresponding γ-amino- and δ-amino-functionalised ethers, amines, and silanes.

Results and Discussion

Synthesis of γ-Amino- and δ-Amino-Functionalised Ethers

It is well established that allylic ethers can be hydroformylated to the corresponding aldehydes in the presence of metal catalysts.[8] The oxo aldehydes thus obtained can be used to prepare α,ω-amino ethers by reductive amination in a separate conversion. We now found that both steps can be performed in a one-pot procedure if primary or secondary amines are present under the typical hydroformylation conditions without suppression of the hydroformylation step by the donor ligands present (Scheme 1, Table 1). Thus, the allylic ethers **1a**, **b** with primary and secondary amines **2a−e** are converted into the corresponding secondary or tertiary γ-amino- and δ-amino-functionalised ethers **3a−f** and **4a** in good to excellent yields and selectivities (Scheme 1, Table 1). Aliphatic as well as aromatic amines can satisfactorily be employed. In case of the unsubstituted allylic ether **1a** the *iso* regioisomer is preferred (entry 1). This can be explained by a precoordinating effect of the ether group influencing the formation of the two acylrhodium species.[9] On the other hand the methallylic group in **1b** by steric effects controls the regioselectivity of the hydroaminomethylation resulting in the exclusive formation of the δ-amino ethers (entry 2−6).



Scheme 1. Hydroaminomethylation of allylic ethers **1a**, **b**

Table 1. Hydroaminomethylation of allylic ethers **1a**, **b**

Entry	R^1	Allyl ether	Amine	Products	Yield [%] **3**
1	H	**1a**	morpholine (**2a**)	**3a**, **4a**	38 (+ 56% **4a**)
2	Me	**1b**	morpholine (**2a**)	**3b**	93
3	Me	**1b**	piperidine (**2b**)	**3c**	88
4	Me	**1b**	diethylamine (**2c**)	**3d**	75
5	Me	**1b**	benzylamine (**2d**)	**3e**	90
6	Me	**1b**	aniline (**2e**)	**3f**	65

Synthesis of γ-Amino- and δ-Amino-Functionalised Silanes

Hydroformylation of allylsilanes hitherto has rarely been investigated.[8d] Under typical hydroformylation conditions

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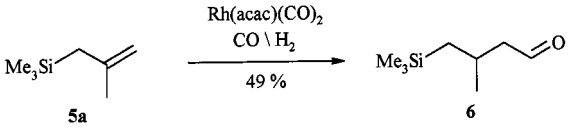
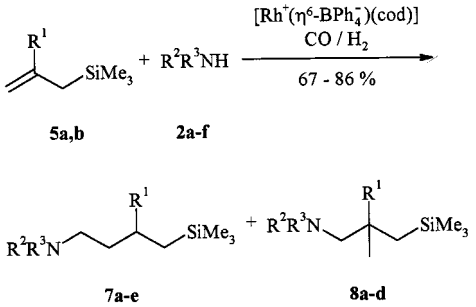


Scheme 2. Hydroformylation of methallyltrimethylsilane (**5a**)



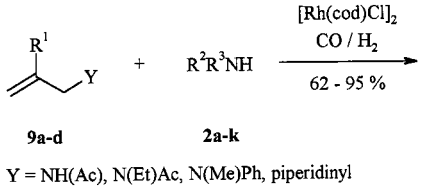
Scheme 3. Hydroaminomethylation of allylsilanes **5a**, **b**

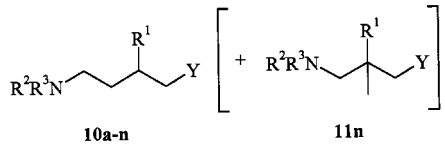
Table 2. Hydroaminomethylation of allyl silanes **5a**, **b**

Entry	R^1	Allylsilane	Amine	Products	Yield [%] **7** + **8**	*n*/*iso* ratio
7	H	**5b**	benzylamine (**2d**)	**7a**, **8a**	67	1.9:1
8	H	**5b**	(*R*)-phenylethyl-amine (**2f**)	**7b**, **8b**	72	2.6:1
9	H	**5b**	*p*-anisidine (**2g**)	**7c**, **8c**	69	1.1:1
10	H	**5b**	morpholine (**2a**)	**7d**, **8d**	86	2.6:1
11	Me	**5a**	morpholine (**2a**)	**7e**	85	–

methallyltrimethylsilane (**5a**) undergoes regioselective hydroformylation to form the corresponding *n*-aldehyde **6** in only moderate yield (Scheme 2).

Surprisingly, allylsilane **5b** and methallylsilane **5a** in the presence of primary or secondary aliphatic amines (**2a**–**c**), as well as aromatic amines (**2d**,**e**) under similar reaction conditions are converted into δ- and γ-aminosilanes (**7a**–**e**, **8a**–**d**) in even significantly higher yields (Scheme 3, Table 2).





Scheme 4. Hydroaminomethylation of allylic protected amines **9a**–**d**

While methallylsilane **5a** gives only the *n* product, allylsilane **5b** yields *n* and *iso* products in a 1.1:1 to 2.6:1 ratio. The regioisomers can be separated by column chromatography.

Synthesis of γ- and δ-Diamines

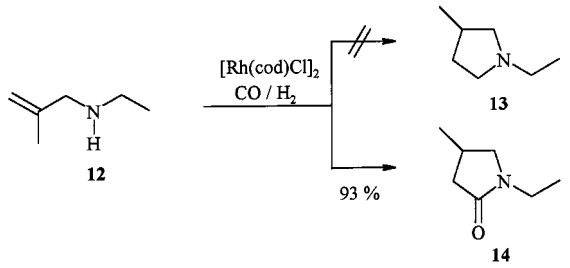
Similar to allylsilanes protected allylic amines **9a**–**d** under hydroaminomethylation conditions react with primary and secondary amines **2a**–**k** to generate 1,4- and 1,3-diamines as the *n* (**10a**–**n**) and the *iso* regioisomers (**11a**) (in case of **9d**) in good to excellent yields.

Similar to allylic ethers and in contrast to allylic silanes unsubstituted allylic amines (entry 25) preferentially are carbonylated in *iso* position. Again this can be explained by a precoordinating effect influencing the formation of the acylrhodium species.

Unprotected allylic amines such as **12** under similar hydroformylation conditions undergo hydrocarboxylative cyclisation to γ-lactams **14**. Comparable results are already reported by other research groups.[10] The generation of the pyrrolidine derivate **13** as expected from an intramolecular hydroaminomethylation sequence is not observed.

Table 3. Hydroaminomethylation of allylic-protected amines

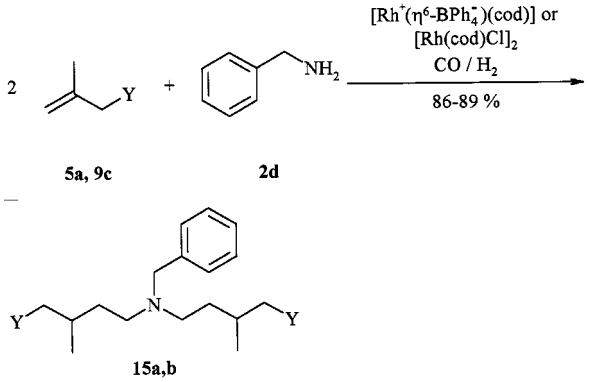
Entry	Y	R^1	Allylamine	Amine	Products	Yield [%] **10**
12	N(Et)Ac	Me	**9a**	morpholine (**2a**)	**10a**	95
13	N(Et)Ac	Me	**9a**	piperidine (**2b**)	**10b**	82
14	N(Et)Ac	Me	**9a**	pyrrolidine (**2h**)	**10c**	90
15	N(Et)Ac	Me	**9a**	diethylamine (**2c**)	**10d**	82
16	N(Et)Ac	Me	**9a**	*N*-methylaniline (**2i**)	**10e**	86
17	N(Et)Ac	Me	**9a**	butylamine (**2j**)	**10f**	62
18	N(Et)Ac	Me	**9a**	isopropylamine (**2k**)	**10g**	64
19	N(Et)Ac	Me	**9a**	benzylamine (**2d**)	**10h**	80
20	N(Et)Ac	Me	**9a**	aniline (**2e**)	**10i**	92
21	piperidinyl	Me	**9b**	morpholine (**2a**)	**10j**	78
22	piperidinyl	Me	**9b**	diethylamine (**2c**)	**10k**	68
23	N(Me)Ph	Me	**9c**	morpholine (**2a**)	**10l**	98
24	N(Me)Ph	Me	**9c**	benzylamine (**2d**)	**10m**	95
25	NH(Ac)	H	**9d**	morpholine (**2a**)	**10n**, **11n**	26 (+ 69% **11n**)



Scheme 5. Intramolecular hydrocarboxylation of ethylmethallylamine (**12**)

Bisalkylation of Primary Amines

The alkylation of the primary amines leading to secondary or tertiary amines can be controlled by the chosen olefin/amine ratio. Mechanistic reasons for this unusual option of selective mono- or bisalkylation of primary amines using this method are discussed elsewhere.[6c] As the following examples show in the presence of two equivalents of olefin **5a**, **9c** the reaction proceeds to form symmetrically substituted tertiary amines **15a**, **b** in good yields (Scheme 6, Table 4).



Scheme 6. Bisalkylation of benzylamine **2d**

Table 4. Bisalkylation of primary amines with two equivalents of olefins

Entry	Y	Allylamine	Products	Yield [%] **15**
26	$SiMe_3$	**5a**	**15a**	86
27	N(Me)Ph	**9c**	**15b**	89

Conclusion

In conclusion we have shown that the rhodium(I)-catalysed one-pot hydroaminomethylation sequence is an efficient method to generate γ-amino- and δ-amino-functionalised ethers, amines, and silanes. All allylic compounds employed in the hydroaminomethylation give the corresponding secondary or tertiary amines in high yields. However, methallyl-functionalised substrates almost completely lead to linear products, whereas allyl moieties are converted into a mixture of branched and linear isomers. According to earlier results the *n*/*iso* ratio can be influenced by addition of phosphane ligands.[7q,11] Further investigation towards an extension of the synthetic potential of this method are in progress.

Experimental Section

General Remarks: The catalyst precursors $[Rh(cod)Cl]_2$ and $Rh(cod)BPh_4$ were prepared as described.[12,13] Column chromatography: Alumina N (activity I) from ICN Biomedicals, Eschwege, or with silica gel 60 from Merck, Darmstadt. − ^1H and ^{13}C NMR: Bruker DPX 300 or DRX 400 in $CDCl_3$ and CH_2Cl_2 or TMS as internal standards. − IR: Nicolet Impact 400 D. − MS: Finnigan CA 5. − Elementary analysis: Leco, CHNS-932. − Analytical gas chromatography: Fisons 8130 gas chromatograph with 30-m CP sil-5 capillaries. − GC MS: Finnigan MAT 8320 (MS). − Pressure reactions have been carried out in autoclaves (type A, 250 mL, PTFE-insert) from Berghof, Eningen, Germany.

General Procedure for the Synthesis of γ-Amino- and δ-Amino-Functionalised Ethers 3a−f, 4a and Amines 10a−n, 11n, 14, 15b: A mixture of the olefin (14.4 mmol) the corresponding amine (14.4 mmol) (in case of **14** 7.2 mmol) and $[Rh(cod)Cl]_2$ (1 mol-%) in anhydrous dioxane (10 mL) was heated for 24 h (**1b**: t = 2 d) at 110°C in an autoclave under 90 bar of carbon monoxide and 20 bar of hydrogen (p_{total} = 110 bar). The solvent was removed by rotary evaporation. The residue was dissolved in Et_2O and filtered through neutral alumina. Product mixtures were separated by column chromatography on neutral alumina using a mixture of MTBE/PE as eluent or by Kugelrohr distillation.

General Procedure for the Preparation of δ-Aminosilanes 7a-e and γ-Aminosilanes 8a−d: A mixture of the allylic silane **5a**, **b** (3.5 mmol), amine **2a−g** (3.9 mmol), $Rh(cod)BPh_4$ (0.035 mmol), and 5 mL of dry toluene was placed in an autoclave. After flushing with argon the reactor was pressurized with 50 bar hydrogen and 50 bar carbon monoxide and heated to 120°C for 20 h. Then the autoclave was allowed to cool to room temperature and the solvent removed by rotary evaporation. The residue was dissolved in *tert*-butyl methyl ether and filtered through neutral alumina. The isolation of the products was carried out by Kugelrohr distillation or column chromatography.

3-Ethoxy-1-propene (1a):[14] **1a** was prepared from allyl bromide and ethanol according to a general literature procedure[15] in 71% yield.

3-Ethoxy-2-methyl-1-propene (1b):[16] **1b** was prepared from methallyl chloride and ethanol according to a general literature procedure[15] in 82% yield.

4-(4-Ethoxybutyl)morpholine (3a): Obtained from **1a** and morpholine (**2a**) as a colourless oil in 38% yield (1.04 g). − ^1H NMR (400 MHz, $CDCl_3$, 20°C): δ = 1.19 (t, ^3J = 7.0 Hz, 3 H), 1.51−1.64 (m, 4 H), 2.35 (t, ^3J = 7.3 Hz, 2 H), 2.43 (br. s, 4 H), 3.42 (t, ^3J = 6.2 Hz, 2 H), 3.46 (q, ^3J = 7.0 Hz, 2 H), 3.71 (t, ^3J = 4.7 Hz, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 15.0 (CH_3), 23.1 (CH_2), 27.5 (CH_2), 53.5 (2 NCH_2), 58.7 (NCH_2), 65.9 (OCH_2), 66.8 (2 OCH_2), 70.2 (OCH_2). − GC MS (EI, 70 eV); *m*/*z* (%): 188 [M^+ + 1] (41), 158 (13), 142 (7), 100 (100), 70 (12), 56 (9). − IR (NaCl/film): $\tilde{\nu}$ = 2943 cm^{-1} (vs), 2892 (s), 2855 (vs), 2806 (vs), 2768 (s), 1456 (m), 1446 (m), 1376 (m), 1356 (m), 1305 (m), 1274 (m), 1263 (m), 1118 (vs), 1071 (m), 1014 (m), 1005 (m), 867 (m). − $C_{10}H_{21}NO_2$ (187.3): calcd. C 64.1, H 11.3, N 7.5; found C 64.1, H 11.2, N, 7.8.

4-(3-Ethoxy-2-methylpropyl)morpholine (4a): Obtained from **1a** and morpholine (**2a**) as a colourless oil in 56% yield (1.54 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.95 (d, ^3J = 6.7 Hz, 3 H), 1.19 (t, ^3J = 7.0 Hz, 3 H), 1.95 (m, 1 H), 2.11 (dd, ^2J = 12.2 Hz, ^3J = 7.5 Hz, 1 H), 2.28 (dd, ^2J = 12.2 Hz, ^3J = 7.1 Hz, 1 H), 2.39 (t, ^3J = 4.1 Hz, 4 H), 3.20 (dd, ^2J = 9.1 Hz, ^3J = 6.9 Hz, 1 H), 3.41 (dd, ^2J = 9.1 Hz, ^3J = 5.1 Hz, 1 H), 3.46 (q, ^3J = 7.0 Hz, 2 H), 3.69 (t, ^3J = 4.7 Hz, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 15.0 (CH_3), 16.0 (CH_3), 30.8 (CH), 54.0 (2 NCH_2), 62.6 (NCH_2), 66.2 (OCH_2), 66.9 (2 OCH_2), 74.5 (OCH_2). − GC MS (EI, 70 eV); *m/z* (%): 188 [M^+ + 1] (38), 142 (3), 100 (100), 70 (10), 56 (3). − IR (NaCl/film): $\tilde{\nu}$ = 2959 cm^{-1} (vs), 2932 (s), 2892 (s), 2854 (vs), 2805 (s), 1457 (m), 1445 (m), 1376 (m), 1357 (m), 1292 (m), 1273 (m), 1120 (vs), 1070 (m), 1014 (m), 868 (m). − $C_{10}H_{21}NO_2$ (187.3): calcd. C 64.1, H 11.3, N 7.5; found C 64.7, H 11.2, N 7.5.

4-(4-Ethoxy-3-methylbutyl)morpholine (3b): Obtained from **1b** and morpholine (**2a**) as a colourless oil in 93% yield (2.69 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.85 (d, ^3J = 6.7 Hz, 3 H), 1.11 (t, ^3J = 7.0 Hz, 3 H), 1.21 (m, 1 H), 1.53 (m, 1 H), 1.68 (m, 1 H), 2.20−2.36 (m, 6 H), 3.16 (m, 2 H), 3.38 (q, ^3J = 7.0 Hz, 2 H), 3.62 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 14.9 (CH_3), 16.9 (CH_3), 30.2 (CH_2), 31.5 (CH), 53.5 (2 × NCH_2), 56.6 (NCH_2), 65.8 (OCH_2), 66.6 (2 OCH_2), 75.8 (OCH_2). − GC MS (EI, 70 eV); *m/z* (%): 202 [M^+ + 1] (54), 172 (12), 156 (7), 115 (6), 100 (100), 70 (9), 56 (7). − IR (NaCl/film): $\tilde{\nu}$ = 2957 cm^{-1} (s), 2930 (s), 2891 (s), 2854 (s), 2806 (s), 1456 (m), 1447 (m), 1378 (m), 1356 (m), 1119 (vs), 1071 (s), 1005 (s), 869 (s). − $C_{11}H_{23}NO_2$ (201.3): calcd. C 65.6, H 11.5, N 7.0; found C 65.3, H 11.2, N 7.2.

1-(4-Ethoxy-3-methylbutyl)piperidine (3c): Obtained from **1b** and piperidine (**2b**) as a colourless oil in 88% yield (2.54 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.92 (d, ^3J = 6.7 Hz, 3 H), 1.18 (t, ^3J = 7.0 Hz, 3 H), 1.29 (m, 1 H), 1.42 (br. s, 2 H), 1.55−1.76 (m, 6 H), 2.25−2.37 (m, 6 H), 3.18 (dd, ^3J = 9.2 Hz, 1 H), 3.27 (dd, ^3J = 9.2 Hz, 1 H), 3.45 (q, ^3J = 7.0 Hz, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 14.9 (CH_3), 17.0 (CH_3), 24.2 (CH_2), 25.7 (2 CH_2), 30.6 (CH_2), 31.9 (CH), 54.4 (2 NCH_2), 57.1 (NCH_2), 65.9 (OCH_2), 75.9 (OCH_2). − GC MS (EI, 70 eV); *m/z* (%): 200 [M^+] (32), 170 (3), 154 (3), 98 (100), 70 (7). − IR (NaCl/film): $\tilde{\nu}$ = 2972 cm^{-1} (s), 2934 (vs), 2855 (s), 2799 (m), 2768 (m), 2739 (m), 1686 (m), 1468 (m), 1454 (m), 1443 (m), 1378 (m), 1156 (m), 1118 (s).

(4-Ethoxy-3-methylbutyl)diethylamine (3d): Obtained from **1b** and diethylamine (**2c**) as a colourless oil in 75% yield (2.02 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.93 (d, ^3J = 6.7 Hz, 3 H), 1.02 (t, ^3J = 7.1 Hz, 6 H), 1.19 (t, ^3J = 7.0 Hz, 3 H), 1.25 (m, 1 H), 1.58 (m, 1 H), 1.72 (m, 1 H), 2.45 (m, 2 H), 2.52 (q, ^3J = 7.1 Hz, 4 H), 3.20 (dd, ^2J = 9.2 Hz, ^3J = 6.8 Hz, 1 H), 3.27 (dd, ^2J = 9.2 Hz, ^3J = 6.1 Hz, 1 H), 3.46 (q, ^3J = 7.0 Hz, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 11.6 (2 CH_3), 15.1 (CH_3), 17.2 (CH_3), 30.6 (CH_2), 31.9 (CH), 46.7 (2 NCH_2), 50.5 (NCH_2), 66.1 (OCH_2), 76.1 (OCH_2). − GC MS (EI, 70 eV); *m/z* (%): 188 [M^+ + 1] (27), 158 (3), 142 (3), 115 (6), 86 (100), 72 (3), 58 (6). − IR (NaCl/film): $\tilde{\nu}$ = 2971 cm^{-1} (s), 2932 (s), 2871 (s), 2799 (s), 1467 (m), 1456 (m), 1379 (m), 1356 (m), 1202 (m), 1115 (s), 1070 (m). − $C_{11}H_{25}NO$ (187.3): calcd. C 70.5, H 13.5, N 7.5; found C 70.2, H 13.0, N 7.8.

Benzyl(4-ethoxy-3-methylbutyl)amine (3e): Obtained from **1b** and benzylamine (**2d**) as a yellow oil in 90% yield (2.87 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.90 (d, ^3J = 6.8 Hz, 3 H), 1.17 (t, ^3J = 7.0 Hz, 3 H), 1.34 (m, 1 H), 1.63 (m, 1 H), 1.79 (m, 1 H), 2.57 (m, 2 H), 3.21 (m, 2 H), 3.43 (q, ^3J = 7.0 Hz, 2 H), 3.78 (m, 2 H), 7.27 (m, 5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 15.1 (CH_3), 17.2 (CH_3), 31.5 (CH), 34.2 (CH_2), 47.2 (NCH_2), 54.0 (NCH_2), 66.1 (OCH_2), 76.1 (OCH_2), 126.7 (PhH), 128.0 (2 PhH), 128.2 (2 PhH), 140.5 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 222 [M^+ + 1] (29), 192 (7), 176 (5), 120 (20), 106 (24), 91 (100), 85 (5), 65 (10). − IR (NaCl/film): $\tilde{\nu}$ = 3325 cm^{-1} (w), 3085 (w), 3063 (w), 3027 (w), 2972 (s), 2928 (s), 2867 (s), 2801 (m), 1682 (w), 1657 (w), 1495 (m), 1454 (s), 1378 (m), 1356 (m), 1114 (vs), 735 (s), 698 (s). − $C_{14}H_{23}NO$ (221.3): calcd. C 76.0, H 10.5, N 6.3; found C 76.1, H 10.4, N 6.4.

(4-Ethoxy-3-methylbutyl)(phenyl)amine (3f): Obtained from **1b** and aniline (**2e**) as a yellow oil in 65% yield (1.94 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.94 (d, ^3J = 6.8 Hz, 3 H), 1.19 (t, ^3J = 7.2 Hz, 3 H), 1.42 (m, 1 H), 1.71 (m, 1 H), 1.86 (m, 1 H), 3.11 (m, 2 H), 3.24 (d, ^3J = 6.4 Hz, 2 H), 3.45 (q, ^3J = 7.2 Hz, 2 H), 6.56 (d, ^3J = 7.5 Hz, 2 H), 6.65 (t*, *J* = 7.2 Hz, *J* = 7.5 Hz, 1 H), 7.14 (t*, *J* = 7.5 Hz, *J* = 8.3 Hz, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 15.0 (CH_3), 17.1 (CH_3), 31.4 (CH), 33.4 (CH_2), 41.6 (NCH_2), 66.1 (OCH_2), 75.8 (OCH_2), 112.4 (2 PhH), 116.7 (PhH), 129.0 (2 PhH), 148.4 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 208 [M^+ + 1] (76), 115 (10), 106 (100), 85 (5), 77 (10), 51 (5). − IR (NaCl/film): $\tilde{\nu}$ = 3391 cm^{-1}(m), 3084 (w), 3052 (m), 3021 (m), 2971 (s), 2930 (s), 2871 (s), 2801 (m), 1603 (s), 1505 (s), 1464 (m), 1442 (m), 1379 (m), 1321 (m), 1260 (m), 1103 (s), 1070 (s). − $C_{13}H_{21}NO$ (207.3): calcd. C 75.3, H 10.2, N 6.8; found C 75.5, H 10.3, N 6.7.

Methallyltrimethylsilane (5a): 5a was prepared from methallyl chloride, magnesium, and trimethylsilyl chloride according to a general literature procedure in 40% yield by Grignard reaction.[17]

3-Methyl-4-trimethylsilylbutyraldehyde (6): Obtained from 5.94 mmol of **5a** in 10 mL of toluene at a pressure of 60 bar (CO/H_2 = 2:1) and a reaction time of 20 h at 65°C in 49% yield (0.46 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.01 (s, 9 H), 0.50 (dd, ^2J = *1*4.7 Hz, ^3J = *8*.8 Hz, 1 H), 0.64 (dd, ^2J = *1*4.7 Hz, ^3J = *4*.8 Hz, 1 H), 0.98 (d, ^3J = *6*.5 Hz, 3 H), 2.17−2.38 (m, 3 H), 9.71 (t, ^3J = *2*.2 Hz, 1 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.7 (CH_3), 23.0 (CH or CH_3), 25.1 (CH or CH_3), 25.3 (CH_2), 54.3 (CH_2), 203.0 (CH). − IR (neat): $\tilde{\nu}$ = 2957 cm^{-1} (s), 1709 (s), 1249 (s), 837 (s).

Benzyl(4-trimethylsilylbutyl)amine (7a): Obtained from **5b** and benzylamine (**2d**) in 44% yield (0.35 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.09 (s, 9 H), 0.60 (m, 2 H), 1.43 (m, 2 H), 1.57 (br. s, 1 H), 1.63 (m, 2 H), 2.72 (t, 2 H, ^3J = 7.5 Hz), 3.79 (s, 2 H), 7.21−7.38 (5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −1.8 (CH_3), 16.5 (CH_2), 21.6 (CH_2), 33.8 (CH_2), 49.1 (CH_2), 54.0 (CH_2), 126.7 (CH), 127.9 (CH), 128.2 (CH), 140.4 (Cq). − IR (neat): $\tilde{\nu}$ = 3308 cm^{-1}(w), 2923 (s), 1495 (m), 1454 (m), 1258 (m), 1247 (s), 862 (s), 835 (s), 697 (s). − GC MS (EI, 70 eV); *m/z* (%): 236 [M^+ + 1] (100), 120 (17), 106 (16), 91 (36), 73 (8). − $C_{14}H_{25}NSi$ (235.4): calcd. C 71.4, H 10.7, N 6.0; found C 71.8, H 10.7, N 5.8.

Benzyl(2-methyl-3-trimethylsilylpropyl)amine (8a): Obtained from **5b** and benzylamine (**2d**) in 23% yield (0.20 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.15 (s, 9 H), 0.49 (dd, 1 H, ^3J = 9.3 Hz, ^2J = 14.6 Hz), 0.82 (dd, 1 H, ^3J = 4.5 Hz, ^2J = 14.6 Hz), 1.08 (d, 3 H, ^3J = 6.5 Hz), 1.47 (br. s, 1 H), 1.91 (m_c 1 H), 2.54 (dd, 1 H, ^3J = 7.0 Hz, ^2J = 11.3 Hz), 2.62 (dd, 1 H, ^3J = 6.0 Hz, ^2J = 11.5 Hz), 4.00 (s, 2 H), 7.33−7.44 (5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.7 (CH_3), 20.9 (CH_3), 22.7 (CH_2), 29.8 (CH), 53.9 (CH_2), 58.8 (CH_2), 126.6 (CH), 127.9 (CH), 128.1 (CH), 140.6 (Cq). − IR (neat): $\tilde{\nu}$ = 3336 cm^{-1} (w), 2953 (s), 1494 (m), 1454 (m), 1248 (m), 1247 (s), 837 (s), 697 (s). − GC MS (EI, 70 eV); *m/z* (%): 236 [M^+ + 1] (100), 120 (63), 106 (7), 91 (96), 73 (42). − $C_{14}H_{25}NSi$ (235.4): calcd. C 71.4, H 10.7, N 6.0; found C 71.4, H 10.6, N 6.0.

(*R*)-Phenylethyl(4-trimethylsilylbutyl)amine (7b): Obtained from **5b** and (*R*)-(+)-phenylethylamine (**2f**) in 52% yield (0.45 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.00 (s, 9 H), 0.48 (m, 2 H), 1.35 (m, 2 H), 1.38 (d, 3 H, ^3J = 6.8 Hz), 1.56 (m, 2 H), 2.48 (m, 2 H), 3.77 (q, 1 H, ^3J = 6.8 Hz), 7.21−7.41 (5 H). NH-proton was not detected. − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −1.7 (CH_3), 16.5 (CH_2), 21.7 (CH_2), 24.3 (CH_3), 34.1 (CH_2), 47.6 (CH_2), 58.4 (CH), 126.4 (CH), 126.7 (CH), 128.3 (CH), 145.9 (Cq). − IR (neat): $\tilde{\nu}$ = 3433 cm^{-1} (w), 2955s, 1451 (m), 1259 (s), 1247 (s), 862 (s), 834 (s), 699 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 250 [M^+ + 1] (100), 105 (64), 73 (10). − $C_{15}H_{27}NSi$ (249.5): calcd. C 72.2, H 10.9, N 5.6; found C 72.6, H 10.6, N, 5.9.

(*R*)-Phenylethyl(2-methyl-3-trimethylsilylpropyl)amine (8b): Obtained from **5b** and (*R*)-(+)-phenylethylamine (**2f**) in 20% yield (0.18 g) as a 1:1 mixture of diastereomers. Spectroscopical data of the obtained mixture of isomers. − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.03 (s, 9 H), 0.04 (s, 9 H), 0.37 (m, 2 × 1 H), 0.64 (dd, 1 H, ^3J = 4.5 Hz, ^2J = 14.6 Hz), 0.70 (dd, 1 H, ^3J = 4.5 Hz, ^2J = 14.6 Hz), 0.97 (d, 2 × 3 H, ^3J = 6.5 Hz), 1.40 (br. s, 2 × 1 H), 1.40 (d, 2 × 3 H, ^3J = 6.5 Hz), 1.76 (m, 2 × 1 H), 2.24 (dd, 1 H, ^3J = 7.8 Hz, ^2J = 11.6 Hz), 2.34 (m, 2 × 1 H), 2.44 (dd, 1 H, ^3J = 5.5 Hz, ^2J = 11.5 Hz), 3.76 (q, 1 H, ^3J = 6.5 Hz), 3.78 (q, 1 H, ^3J = 6.5 Hz), 7.20−7.38 (2 × 5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.7 (2 CH_3), 20.9 (CH_3), 21.2 (CH_3), 22.7 (CH_2), 23.0 (CH_2), 24.5 (2 CH_3), 29.1 (CH), 30.1 (CH), 57.2 (CH_2), 57.3 (CH_2), 58.1 (CH), 58.3 (CH), 126.5 (2 CH), 126.7 (CH), 128.3 (CH), 146.1 (Cq). − IR (neat): $\tilde{\nu}$ = 3347 cm^{-1} (w), 2955 (s), 1451 (m), 1248 (s), 861 (s), 836 (s), 759 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 250 [M^+ + 1] (18), 134 (21), 105 (100), 91 (96), 73 (25). − $C_{15}H_{27}NSi$ (249.5): calcd. C 72.2, H 10.9, N 5.6; found C 72.2, H 10.8, N 5.8.

(4-Methoxyphenyl)(4-trimethylsilylbutyl)amine (7c): Obtained from **5b** and *p*-anisidine (**2g**) in 36% yield (0.32 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.22 (s, 9 H), 0.55 (m, 2 H), 1.43 (m, 2 H), 1.64 (m, 2 H), 3.08 (t, 2 H, ^3J = 7.1 Hz), 3.76 (s, 3 H), 6.60 (d, 2 H, ^3J = 8.9 Hz), 6.81 (d, 2 H, ^3J = 8.9 Hz). NH signal was not detected. − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −1.7 (CH_3), 16.5 (CH_2), 21.6 (CH_2), 33.5 (CH_2), 44.7 (CH_2), 55.7 (CH_3), 113.9 (CH), 114.8 (CH), 142.9 (Cq), 151.9 (Cq). − IR (neat): $\tilde{\nu}$ = 3397 cm^{-1} (vs), 2951 (s), 1513 (s), 1294 (s), 1246 (s), 861 (s), 834 (s), 818 (s), 691 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 251 [M^+] (100), 136 (80), 108 (10), 73 (19). − $C_{14}H_{25}ONSi$ (251.4): calcd. C 66.9, H 10.0, N 5.6; found C 66.8, H 9.8, N, 5.8.

(4-Methoxyphenyl)(2-methyl-3-trimethylsilylpropyl)amine (8c): Obtained from **5b** and *p*-anisidine (**2g**) in 33% yield (0.29 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.05 (s, 9 H), 0.43 (dd, 1 H, ^3J = 9.5 Hz, ^2J = 14.6 Hz), 0.72 (dd, 1 H, ^3J = 4.3 Hz, ^2J = 14.6 Hz), 0.99 (d, 3 H, ^3J = 6.5 Hz), 1.86 (m, 1 H), 2.83 (dd, 1 H, ^3J = 7.3 Hz, ^2J = 12.0 Hz), 2.95 (dd, 1 H, ^3J = 5.8 Hz, ^2J = 11.8 Hz), 3.73 (s, 3 H), 6.75 (d, 2 H, ^3J = 8.8 Hz), 6.79 (d, 2 H, ^3J = 8.8 Hz). NH signal was not detected. − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.7 (CH_3), 20.9 (CH_3), 22.7 (CH_2), 29.6 (CH), 54.3 (CH_2), 55.8 (CH_3), 113.9 (CH), 114.9 (CH), 142.8 (Cq), 151.8 (Cq). − IR (neat): $\tilde{\nu}$ = 3411 cm^{-1} (vs), 2952 (s), 1513 (s), 1247 (s), 1234 (s), 837 (s), 817 (m), 692 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 251 [M^+] (28), 136 (100), 73 (42). − $C_{14}H_{25}ONSi$ (251.4): calcd. C 66.9, H 10.0, N 5.6; found C 67.0, H 9.8, N 5.8.

4-(4-Trimethylsilylbutyl)morpholine (7d): Obtained from **5b** and morpholine (**2a**) in 62% yield (0.47 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = −0.02 (s, 9 H), 0.49 (m, 2 H), 1.31 (m, 2 H), 1.51 (m, 2 H), 2.32 (t, 2 H, ^3J = 7.7 Hz), 2.43 (m, 4 H), 3.71 (t, 4 H, ^3J = 4.5 Hz). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −1.8 (CH_3), 16.5 (CH_2), 21.8 (CH_2), 30.2 (CH_2), 53.7 (CH_2), 58.8 (CH_2), 66.8 (CH_2). − IR (neat): $\tilde{\nu}$ = 2953 cm^{-1} (s), 1456 (m), 1445 (m), 1274 (m), 1247 (s), 1120 (s), 861 (s), 835 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 216 [M^+ + 1] (6), 200 (9), 100 (100), 70 (12). − $C_{11}H_{25}NOSi$ (215.4): calcd. C 61.3, H 11.7, N 6.5; found C 61.7, H 11.2, N 6.4.

4-(2-Methyl-3-trimethylsilylpropyl)morpholine (8d): Obtained from **5b** and morpholine (**2a**) in 24% yield (0.18 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.02 (s, 9 H), 0.30 (dd, 1 H, ^3J = 9.0 Hz, ^2J = 14.6 Hz), 0.73 (dd, 1 H, ^3J = 4.3 Hz, ^2J = 14.8 Hz), 0.93 (d, 3 H, ^3J = 6.5 Hz), 1.77 (m, 1 H), 2.08 (m, 2 H), 2.37 (m, 4 H), 3.70 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.6 (CH_3), 21.2 (CH_3), 22.8 (CH_2), 26.5 (CH), 53.9 (CH_2), 66.9 (CH_2), 68.9 (CH_2). − IR (neat): $\tilde{\nu}$ = 2955 cm^{-1} (s), 1455 (m), 1248 (s), 1120 (s), 860 (s), 836 (s), 690 (s). − GC MS (EI, 70 eV); *m*/*z* (%): 216 [M^+ + 1] (15), 200 (9), 100 (100), 70 (9). − $C_{11}H_{25}NOSi$ (215.4): calcd. C 61.3, H 11.7, N 6.5; found C 61.1, H 11.2, N 6.6.

4-(3-Methyl-4-trimethylsilylbutyl)morpholine (7e): Obtained from **5a** and morpholine (**2a**) in 85% yield (0.68 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = −0.02 (s, 9 H), 0.40 (dd, 1 H, ^2J = 14.6 Hz, ^3J = 8.8 Hz), 0.61 (dd, 1 H, ^2J = 14.6 Hz, ^3J = 4.8 Hz), 0.90 (d, 3 H, ^3J = 6.6 Hz), 1.33 (m, 1 H), 1.45 (mc, 1 H), 1.59 (m, 1 H), 2.32 (m_c, 2 H), 2.42 (br. s, 4 H), 3.69 (t, 4 H, ^3J = 4.7 Hz). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.6 (CH_3), 22.9 (CH_3), 25.3 (CH_2), 28.1 (CH), 37.1 (CH_2), 53.9 (CH_2), 57.3 (CH_2), 66.9 (CH_2). − IR (neat): $\tilde{\nu}$ = 2956 cm^{-1} (s), 1457 (m), 1447 (m), 1275 (m), 1248 (s), 1120 (s), 856 (s), 837 (s). − $C_{12}H_{27}NOSi$ (229.4): calcd. C 62.8, H 11.9, N 6.1; found C 62.9, H 11.7, N 6.5.

***N*-Ethyl-*N*-(2-methylallyl)acetamide (9a):**[18] **9a** was prepared from ethyl(2-methylallyl)amine and acetic anhydride according to a general literature procedure[19] in 76% yield.

1-(2-Methylallyl)piperidine (9b):[20] **9b** was prepared from methallyl chloride and piperidine according to a general literature procedure[15] in 50% yield.

Methyl(2-methylallyl)(phenyl)amine (9c): 9c was prepared from *N*-methylaniline and methallyl chloride according to a general literature procedure[14] for the synthesis of allylic ethers in 53% yield. − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 1.70 (s, 3 H), 2.92 (s, 3 H), 3.76 (s, 2 H), 4.78 (s, 1 H), 4.83 (s, 1 H), 6.66 (t*, *J* = 2.8 Hz, *J* = 5.7 Hz, 3 H), 7.18 (d, ^3J = 7.2 Hz, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 20.0 (CH_3), 38.1 (NCH_3), 58.7 (NCH_2), 110.6 (CH_2), 111.9 (2 PhH), 116.0 (PhH), 129.0 (2 PhH), 141.4 (Cq), 149.5 (Cq). − GC MS (EI, 70 eV); *m*/*z* (%): 161 [M^+] (77), 146 (14), 130 (4), 120 (100), 104 (7), 77 (11), 51 (11). − IR (NaCl/film): $\tilde{\nu}$ = 3087 cm^{-1} (w), 3064 (w), 3028 (w), 2972 (m), 2931 (m), 2909 (m), 2867 (m), 1656 (w), 1600 (s), 1506 (s), 1447 (m), 1371 (s), 748 (s), 691 (s). − $C_{11}H_{15}N$ (161.2): calcd. C 81.9, H 9.4, N 8.7; found C 81.5, H 9.4, N 8.8.

***N*-Allylacetamide (9d): 9d** was prepared from allylamine and acetic anhydride according to a general literature procedure[16] in 87% yield. − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 2.00 (s, 3 H), 3.84 (dd, ^3J = 4.1 Hz, ^2J = 1.2 Hz, 2 H), 5.10 (dd, ^3J = 10.2 Hz, ^2J = 1.5 Hz, 1 H), 5.18 (dd, ^3J = 17.2 Hz, ^2J = 1.5 Hz, 1 H), 5.83 (m, 1 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 22.5 (CH_3), 41.5 (NCH_2), 115.5 (*C*H_2=CHR), 133.9 (*C*HR=CH_2), 170.3 (Cq, C=O). − GC MS (EI, 70 eV); *m*/*z* (%): 100 [M^+ + 1] (35), 84 (6), 57 (100), 51(3). − IR (NaCl/film): $\tilde{\nu}$ = 3306 cm^{-1} (s), 3293 (m), 1653 (s), 1558 (s), 1540 (s), 1456 (m), 1430 (m), 1374 (m), 1284 (m), 605 (m). − C_5H_9NO (99.1): calcd. C 60.6, H 9.2, N 14.1; found C 60.4, H 9.1, N 14.2.

***N*-Ethyl-*N*-(2-methyl-4-morpholin-4-ylbutyl)acetamide (10a):** Obtained from **9a** and morpholine (**2a**) as a colourless oil in 95% yield

(3.32 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.89/0.94 (2 d, ^3J = 6.7 Hz, 3 H), 1.11/1.17 (2 t, ^3J = 7.1 Hz, 3 H), 1.29 (m, 1 H), 1.56 (m, 1 H), 1.89 (m, 1 H), 2.07/2.10 (2 s, 3 H), 2.34 (m, 2 H), 2.40 (m, 4 H), 3.03−3.40 (m, 4 H), 3.69 (t, ^3J = 4.6 Hz, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 11.8/12.9 (CH_3), 16.7/16.8 (CH_3), 20.6/21.1 (CH_3), 29.4/29.9 (CH), 30.1/30.3 (CH_2), 39.8/42.5 (NCH_2), 49.7/53.5 (NCH_2), 53.0 (2 NCH_2), 55.7/56.0 (NCH_2), 66.1 (2 CH_2O), 169.2/169.4 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 243 [M^+ + 1] (38), 211 (3), 156 (22), 112 (8), 100 (100), 70 (14), 58 (19). − IR (NaCl/film): $\tilde{\nu}$ = 2958 cm^{-1} (s), 2931 (s), 2870 (m), 2854 (m), 2807 (m), 1647 (vs), 1456 (s), 1447 (s), 1424 (s), 1377 (m), 1360 (m), 1274 (m), 1133 (m), 1118 (vs). − $C_{13}H_{26}N_2O_2$ (242.4): calcd. C 64.4, H 10.8, N 11.6; found C 64.2, H 10.5, N 11.7.

***N*-Ethyl-*N*-(2-methyl-4-piperidin-1-ylbutyl)acetamide (10b):** Obtained from **9a** and piperidine (**2b**) as a colourless oil in 82% yield (2.85 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.87/0.92 (2 d, ^3J = 6.7 Hz, 3 H), 1.10/1.16 (2 t, ^3J = 7.1 Hz, 3 H), 1.27 (m, 1 H), 1.42 (m, 1 H), 1.61 (m, 6 H), 1.85 (m, 1 H), 2.07/2.10 (2 s, 3 H), 2.25 (m, 2 H), 2.38 (m, 4 H), 3.01−3.49 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.4/13.5 (CH_3), 17.3/17.4 (CH_3), 21.3/21.7 (CH_3), 24.21/24.23 (CH_2), 25.8 (2 CH_2), 30.3/31.0 (CH), 31.2/31.3 (CH_2), 40.4/43.2 (NCH_2), 50.5/54.2 (NCH_2), 54.44/54.45 (2 NCH_2), 56.8/57.1 (NCH_2), 170.0/170.1 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 241 [M^+ + 1] (30), 154 (3), 112 (8), 98 (100), 84 (8), 70 (8), 58 (11). − IR (NaCl/film): $\tilde{\nu}$ = 2932 cm^{-1} (s), 2874 (m), 2853 (m), 1648 (vs), 1442 (s), 1424 (s), 1377 (m), 1356 (w), 1271 (m). − $C_{14}H_{28}N_2O$ (240.4): calcd. C 69.9, H 11.8, N 11.7; found C 69.5, H 11.5, N 11.8.

***N*-Ethyl-*N*-(2-methyl-4-pyrrolidin-1-ylbutyl)acetamide (10c):** Obtained from **9a** and pyrrolidine (**2h**) as a colourless oil in 90% yield (2.92 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.89/0.94 (2 d, ^3J = 6.7 Hz, 3 H), 1.10/1.16 (2 t, ^3J = 7.1 Hz, 3 H), 1.32 (m, 1 H), 1.62 (m, 1 H), 1.77 (m, 4 H), 1.90 (m, 1 H), 2.07/2.10 (2 s, 3 H), 2.43 (m, 2 H), 2.48 (m, 4 H), 3.03−3.42 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.3/13.4 (CH_3), 17.2/17.2 (CH_3), 21.2/21.6 (CH_3), 23.05 (CH_2), 23.07 (CH_2), 30.1/30.8 (CH), 33.3 (CH_2), 40.3/43.2 (NCH_2), 50.4/53.5 (NCH_2), 53.84/54.02 (NCH_2), 53.9 (2 NCH_2), 169.9/170.1 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 227 [M^+] (39), 140 (3), 112 (6), 84 (100), 70 (3), 58 (6). − IR (NaCl/film): $\tilde{\nu}$ = 2961 cm^{-1} (vs), 2931 (vs), 2873 (s), 2855 (s), 2805 (s), 1643 (vs), 1480 (m), 1456 (vs), 1425 (vs), 1379 (m), 1361 (m), 1274 (m), 1118 (s), 1033 (m).

***N*-(4-Diethylamino-2-methylbutyl)-*N*-ethylacetamide (10d):** Obtained from **9a** and diethylamine (**2c**) as a colourless oil in 82% yield (2.70 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.88/0.93 (2 d, ^3J = 6.5 Hz, 3 H), 1.01 (t, ^3J = 6.5 Hz, 6 H), 1.11/1.17 (2 t, ^3J = 7.1 Hz, 3 H), 1.23 (m, 1 H), 1.52 (m, 1 H), 1.84 (m, 1 H), 2.07/2.11 (2 s, 3 H), 2.35 (m, 2 H), 2.49 (m, 4 H), 3.02−3.38 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 11.0 (2 CH_3), 11.9/13.1 (CH_3), 16.8/16.9 (CH_3), 20.8/21.3 (CH_3), 29.6/30.2 (CH), 31.0 (CH_2), 40.0/42.7 (NCH_2), 46.1 (2 NCH_2), 49.9/53.9 (NCH_2), 50.0 (NCH_2), 169.5/169.6 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 229 [M^+ + 1] (50), 156 (7), 112 (7), 86 (100), 72 (6), 58 (14). − IR (NaCl/film): $\tilde{\nu}$ = 2968 cm^{-1} (vs), 2932 (s), 2873 (m), 2799 (m), 1649 (vs), 1446 (s), 1424 (s), 1380 (m), 1272 (m), 1122 (w), 1073 (w), 1033 (w). − $C_{13}H_{28}N_2O$ (228.4): calcd. C 68.4, H 12.4, N 12.3; found C 67.8, H 11.7, N 12.1.

***N*-(4-Benzylamino-2-methylbutyl)-*N*-ethylacetamide (10e):** Obtained from **9a** and *N*-methylaniline (**2i**) as an orange oil in 86% yield (3.25 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.93/0.98 (2 d, ^3J = 6.8 Hz, 3 H), 1.08/1.12 (2 t, ^3J = 7.0 Hz, 3 H), 1.34 (m, 1 H), 1.63 (m, 1 H), 1.85 (m, 1 H), 2.04/2.08 (2 s, 3 H), 2.89 (s, 3 H), 3.02−3.45 (m, 6 H), 6.58−6.70 (m, 3 H), 7.17−7.26 (m, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.5/13.6 (CH_3), 17.2/17.4 (CH_3), 21.3/21.8 (CH_3), 29.7/30.5 (CH), 30.6/30.7 (CH_2), 37.97/37.99 (NCH_3), 40.5/43.4 (NCH_2), 50.4/50.5 (NCH_2), 50.5/54.4 (NCH_2), 112.0/112.1 (2 PhH), 115.8/116.2 (PhH), 129.0/129.1 (2 PhH), 148.98/149.03 (Cq), 170.1/170.3 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 262 [M^+] (14), 120 (100), 104 (7), 77 (7), 58 (14). − IR (NaCl/film): $\tilde{\nu}$ = 3092 cm^{-1} (w), 3059 (w), 3024 (w), 2964 (s), 2930 (s), 2874 (m), 1645 (vs), 1600 (vs), 1574 (m), 1507 (vs), 1480 (m), 1444 (s), 1425 (s), 1372, 1272 (m), 1255 (m), 1193 (m), 1121 (m), 1034 (m), 749 (s), 693 (m). − $C_{16}H_{26}N_2O$ (262.4): calcd. C 73.2, H 10.0, N 10.7; found C 72.7, H 9.7, N 10.6.

***N*-(4-Butylamino-2-methylbutyl)-*N*-ethylacetamide (10f):** Obtained from **9a** and *n*-butylamine (**2j**) as a colourless oil in 62% yield (2.03 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.88/0.93 (2 d, ^3J = 6.7 Hz, 3 H), 0.91 (t, ^3J = 7.4 Hz, 3 H), 1.10 /1.16 (2 t, ^3J = 7.1 Hz, 3 H), 1.33 (m, 3 H), 1.52 (m, 3 H), 1.92 (m, 1 H), 2.07/2.10 (2 s, 3 H), 2.54−2.74 (m, 4 H), 3.03−3.40 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 11.9/13.1 (CH_3), 13.4 (CH_3), 16.8/17.0 (CH_3), 19.9 (CH_2), 20.8/21.3 (CH_3), 29.3/30.2 (CH), 31.7 (CH_2), 34.1 (CH_2), 40.0/43.0 (NCH_2), 47.2 (NCH_2), 49.19/49.23 (NCH_2), 50.2/53.9 (NCH_2), 169.5/169.7 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 229 [M^+ + 1] (100), 156 (9), 140 (4), 112 (14), 100 (7), 58 (18). − IR (NaCl/film): $\tilde{\nu}$ = 3306 cm^{-1} (m), 2959 (s), 2930 (s), 2873 (s), 2814 (m), 1644 (vs), 1457 (s), 1425 (s), 1379 (s), 1366 (m), 1271 (m), 1126 (m), 1096 (m), 1033 (m), 732 (m). − $C_{13}H_{28}N_2O$ (228.4): calcd. C 68.4, H 12.4, N 12.3; found C 68.1, H 12.2, N 12.5.

***N*-Ethyl-*N*-(4-isopropylamino-2-methylbutyl)acetamide (10g):** Obtained from **9a** and isopropylamine (**2k**) as a colourless oil in 64% yield (1.98 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.88/0.93 (2 d, ^3J = 6.6 Hz, 3 H), 1.05 (d, ^3J = 7.3 Hz, 3 H), 1.06 (d, ^3J = 7.3 Hz, 3 H), 1.11/1.16 (2 t, ^3J = 7.1 Hz, 3 H), 1.27 (m, 1 H), 1.53 (m, 1 H), 1.82 (m, 1 H), 2.07/2.10 (2 s, 3 H), 2.53−2.80 (m, 3 H), 3.03−3.40 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.3/13.4 (CH_3), 17.1/17.3 (CH_3), 21.2/21.6 (CH_3), 22.61/22.70 (CH_3), 22.74/22.78 (CH_3), 29.7/30.6 (CH), 34.7/34.8 (CH_2), 40.3/43.3 (NCH_2), 44.96/44.99 (NCH_2), 48.5 (NCH), 50.5/54.2 (NCH_2), 169.9/170.1 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 215 [M^+ + 1] (100), 171 (4), 156 (21), 126 (8), 112 (47), 100 (11), 84 (10), 72 (17), 58 (75). − IR (NaCl/film): $\tilde{\nu}$ = 3305 cm^{-1} (w), 2965 (s), 2930 (s), 2873 (m), 1645 (vs), 1456 (s), 1444 (s), 1425 (s), 1379 (m), 1363 (m), 1272 (m), 1033 (m). − $C_{12}H_{26}N_2O$ (214.4): calcd. C 67.2, H 12.2, N 13.1; found C 66.9, H 11.9, N 13.2.

***N*-(4-Benzamino-2-methylbutyl)-*N*-ethylacetamide (10h):** Obtained from **9a** and benzylamine (**2d**) as a yellow oil in 80% yield (3.00 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.86/0.90 (2 d, ^3J = 6.6 Hz, 3 H), 1.09/1.13 (2 t, ^3J = 7.1 Hz, 3 H), 1.27 (m, 1 H), 1.52 (m, 1 H), 1.90 (m, 1 H), 2.04/2.08 (2 s, 3 H), 2.60 (m, 2 H), 2.83 (m, 2 H), 3.01−3.37 (m, 4 H), 3.766/3.773 (2 s, 2 H), 7.22−7.31 (m, 5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.3/13.5 (CH_3), 17.1/17.3 (CH_3), 21.2/21.7 (CH_3), 29.7/30.4 (CH), 34.4 (CH_2), 40.4/43.3 (NCH_2), 46.8/46.9 (NCH_2), 50.5/54.2 (CH_2), 53.9 (NCH_2Ph), 126.5/126.6 (PhH), 127.8 (2 PhH), 128.1 (2 PhH), 140.1/140.3 (Cq), 170.0/170.1 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 263 [M^+ + 1] (33), 171 (11), 156 (10), 120 (7), 112 (28), 91 (50), 84 (10), 65 (8), 58 (36). − IR (NaCl/film): $\tilde{\nu}$ = 3307 cm^{-1} (w), 3061 (w), 3026 (w), 2965 (m), 2929 (m), 2873 (w), 1644 (vs), 1478 (w), 1453 (m), 1425 (m), 1272 (w), 737 (w), 699 (w). − $C_{16}H_{26}N_2O$ (262.4): calcd. C 73.2, H 10.0, N 10.7; found C 73.0, H 9.8, N 10.7.

***N*-Ethyl-*N*-(2-methyl-4-phenylaminobutyl)acetamide (10i):** Obtained from **9a** and aniline (**2e**) as an orange oil in 92% yield (3.27 g). −

^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.92/0.96 (2 d, ^3J = 6.7 Hz, 3 H), 1.09/1.13 (2 t, ^3J = 7.1 Hz, 3 H), 1.40 (m, 1 H), 1.65 (m, 1 H), 1.95 (m, 1 H), 2.05/2.08 (2 s, 3 H), 3.03−3.38 (m, 6 H), 6.59 (m, 2 H), 6.67 (m, 1 H), 7.15 (m, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.3/13.4 (CH_3), 16.9/17.2 (CH_3), 21.1/21.6 (CH_3), 29.4/30.2 (CH), 33.3/33.6 (CH_2), 40.3/43.2 (NCH_2), 41.2/41.3 (NCH_2), 50.3/54.0 (NCH_2), 112.3 (2 PhH), 116.5/116.8 (PhH), 128.7/128.8 (2 PhH), 148.0/148.1 (Cq), 169.9/170.1 (Cq, C=O). − GC MS (EI, 70 eV); *m/z* (%): 248 [M^+] (29), 160 (5), 128 (16), 106 (100), 93 (19), 77 (38), 58 (100), 51 (21). − IR (NaCl/film): $\tilde{\nu}$ = 3346 cm^{-1} (s), 3051 (m), 3021 (m), 2965 (s), 2930 (s), 2873 (s), 1635 (vs), 1603 (vs), 1500 (vs), 1480 (s), 1456 (s), 1426 (vs), 1380 (s), 1323 (s), 1267 (s), 1224 (m), 1179 (m), 1121 (m), 1033 (s), 750 (s), 694 (s), 510 (m). − $C_{15}H_{24}N_2O$ (248.4): calcd. C 72.5, H 9.8, N 11.3; found C 72.3, H 9.5, N 11.3.

4-(3-Methyl-4-piperidinobutyl)morpholine (10j): Obtained from **9b** and morpholine (**2a**) as a colourless oil in 78% yield (2.71 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.89 (d, ^3J = 6.5 Hz, 3 H), 1.23 (m, 1 H), 1.41 (m, 2 H), 1.51−1.73 (m, 6 H), 2.00−2.11 (m, 2 H), 2.29−2.43 (m, 10 H), 3.71 (t, ^3J = 4.4 Hz, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 18.6 (CH_3), 24.5 (CH_2), 26.0 (2 CH_2), 28.8 (CH), 31.9 (CH_2), 53.8 (2 NCH_2), 55.0 (2 NCH_2), 57.0 (NCH_2), 66.5 (NCH_2), 67.0 (2 OCH_2). − GC MS (EI, 70 eV); *m/z* (%): 241 [M^+] (20), 222 (7), 154 (18), 138 (7), 112 (7), 98 (100), 86 (4), 70 (9), 56 (4). − IR (NaCl/film): $\tilde{\nu}$ = 293 cm^{-1}3 (vs), 2853 (s), 2802 (s), 2767 (s), 2691 (m), 1465 (m), 1443 (m), 1374 (m), 1302 (m), 1274 (m), 1154 (m), 1120 (s), 1039 (m), 1004 (m).

Diethyl(3-methyl-4-piperidinobutyl)amine (10k): Obtained from **9b** and diethylamine (**2c**) as a colourless oil in 68% yield (2.23 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.82 (d, ^3J = 6.6 Hz, 3 H), 0.95 (t, ^3J = 7.2 Hz, 6 H), 1.13 (m, 1 H), 1.33 (d, ^3J = 5.3 Hz, 2 H), 1.44−1.63 (m, 6 H), 1.98 (m, 2 H), 2.24 (m, 4 H), 2.43 (m, 6 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 11.6 (2 CH_3), 18.5 (CH_3), 24.5 (CH_2), 26.0 (2 CH_2), 28.8 (CH), 32.0 (CH_2), 46.7 (2 NCH_2), 50.5 (NCH_2), 54.9 (2 NCH_2), 66.4 (NCH_2). − GC MS (EI, 70 eV); *m/z* (%): 227 [M^+ + 1] (21), 197 (25), 154 (25), 112 (13), 98 (100), 86 (41), 70 (11), 56 (5). − IR (NaCl/film): $\tilde{\nu}$ = 2967 cm^{-1} (s), 2934 (vs), 2871 (s), 2854 (s), 2799 (s), 1468 (m), 1456 (m), 1443 (m), 1375 (m), 1300 (m), 1156 (m), 1118 (m), 1097 (m). − $C_{14}H_{30}N$ (226.4): calcd. C 74.3, H 13.4, N 12.4; found C 74.1, H 12.8, N 12.0.

Methyl(2-methyl-4-morpholinobutyl)(phenyl)amine (10l): Obtained from **9c** and morpholine (**2a**) as a colourless oil in 98% yield (3.72 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.92 (d, ^3J = 6.6 Hz, 3 H), 1.30 (m, 1 H), 1.62 (m, 1 H), 2.01 (m, 1 H), 2.28−2.59 (m, 6 H), 2.94 (s, 3 H), 3.02 (dd, ^2J = 14.5 Hz, ^3J = 8.0 Hz, 1 H), 3.25 (dd, ^2J = 14.5 Hz, ^3J = 6.7 Hz), 3.69 (m, 4 H), 6.67 (t*, *J* = 7.4 Hz, *J* = 8.2 Hz, 3 H), 7.2 (t*, *J* = 7.4 Hz, *J* = 8.4 Hz, 2 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 17.9 (CH_3), 30.3 (CH), 31.2 (CH_2), 39.5 (NCH_3), 53.9 (2 NCH_2), 56.7 (NCH_2), 59.6 (NCH_2), 66.9 (2 OCH_2), 111.7 (2 PhH), 115.6 (PhH), 128.9 (2 PhH), 149.4 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 262 [M^+ + 1] (13), 244 (6), 176 (12), 156 (32), 120 (100), 100 (37), 77 (3). − IR (NaCl/film): $\tilde{\nu}$ = 3093 cm^{-1} (w), 3060 (w), 3025 (w), 2955 (s), 2924 (s), 2891 (s), 2854 (s), 2808 (s), 1600 (s), 1507 (vs), 1456 (m), 1449 (m), 1373 (m), 1357 (m), 1119 (vs), 748 (s), 693 (m). − $C_{16}H_{26}N_2O$ (262.4): calcd. C 73.2, H 10.0, N 10.7; found C 72.8, H 9.8, N 10.3.

***N*^{4}-Benzyl-2,*N*^{1}-dimethyl-*N*^{1}-phenylbutane-1,4-diamine (10m):** Obtained from **9c** and benzylamine (**2d**) as a yellow oil in 95% yield (3.84 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.89 (d, ^3J = 6.5 Hz, 3 H), 1.28 (m, 1 H), 1.60 (m, 1 H), 1.98 (br. s, 1 H), 2.66 (m, 2 H), 2.92 (s, 3 H), 3.04 (m, 1 H), 3.19 (m, 1 H), 3.75 (s, 2 H), 6.66 (d, ^3J = 6.6 Hz, 3 H), 7.25 (m, 7 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 17.8 (CH_3), 30.4 (CH), 34.9 (CH_2), 39.5 (NCH_3), 47.3(NCH_2), 54.1 (NCH_2), 59.8 (NCH_2), 111.8 (2 PhH), 115.6 (PhH), 126.8 (PhH), 128.0 (2 PhH), 128.3 (2 PhH), 129.0 (PhH), 140.4 (Cq), 149.5 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 281 [M^+ + 1] (28), 266 (9), 233 (100), 218 (6), 176 (71), 120 (94), 91 (19), 56 (4). − IR (NaCl/film): $\tilde{\nu}$ = 3368 cm^{-1} vw, 3085 (w), 3061 (w), 3026 (w), 2952 (m), 2926 (m), 2868 (m), 1600 (s), 1507 (vs), 1453 (m), 1373 (m).

***N*-(4-Morpholinobutyl)acetamide (10n):** Obtained from **9d** and morpholine (**2a**) as a colourless oil in 26% yield (0.75 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 1.54 (br. s, 4 H), 1.96 (s, 3 H), 2.37 (m, 2 H), 2.43 (br. s, 4 H), 3.23 (m, 2 H), 3.70 (br. s, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 22.8 (CH_3), 23.6 (CH_2), 27.0 (CH_2), 39.0 (NCH_2), 53.1 (2 NCH_2), 58.1 (NCH_2), 66.6 (2 OCH_2), 169.9 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 201 [M^+ + 1] (44), 169 (3), 141 (10), 114 (6), 100 (100), 70 (24), 56 (18). − IR (NaCl/film): $\tilde{\nu}$ = 3304 cm^{-1} (s), 2958 (s), 2930 (s), 2895 (s), 2854 (s), 2809 (s), 1651 (vs), 1557 (s), 1540 (s), 1456 (s), 1445 (m), 1373 (m), 1296 (m), 1119 (vs), 1014 (m), 865 (m).

***N*-(2-methyl-3-morpholinopropyl)acetamide (11n):** Obtained from **9d** and morpholine (**2a**) as a colourless oil in 69% yield (1.98 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.73 (d, ^3J = 6.8 Hz, 3 H), 1.81 (s, 3 H), 2.19 (m, 4 H), 2.41 (d, ^3J = 4.1 Hz, 2 H), 2.77 (m, 1 H), 3.37 (m, 2 H), 3.55 (m, 4 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 16.7 (CH_3), 23.0 (CH_3), 28.6 (CH), 46.1 (NCH_2), 53.7 (2 NCH_2), 65.5 (NCH_2), 66.8 (2 OCH_2), 169.5 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 201 [M^+ + 1] (29), 141 (6), 114 (6), 100 (100), 70 (18), 56 (15). − IR (NaCl/film): $\tilde{\nu}$ = 3305 cm^{-1} (s), 2960 (s), 2933 (s), 2895 (m), 2857 (s), 2811 (m), 1658 (vs), 1553 (s), 1456 (s), 1444 (s), 1371 (m), 1294 (s), 1118 (vs), 918 (m), 865 (m), 732 (s).

1-Ethyl-4-methylpyrrolidin-2-one (14): Obtained from **12** as a colourless oil in 93% yield (1.80 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 1.11 (t, ^3J = 7.3 Hz, 3 H), 1.13 (d, ^3J = 6.7 Hz, 3 H), 2.01 (dd, ^2J = 16.2 Hz, ^3J = 6.5 Hz, 1 H), 2.43 (m, 1 H), 2.54 (dd, ^2J = 16.2 Hz, ^{3} ^{J} = 8.6 Hz, 1 H), 2.96 (dd, ^2J = 9.5 Hz, ^3J = 5.8 Hz, 1 H), 3.32 (dd, ^2J = 7.2 Hz, ^3J = 4.6 Hz, 2 H), 3.50 (dd, ^2J = 9.5 Hz, ^3J = 7.7 Hz, 1 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 12.2 (CH_3), 19.6 (CH_3), 26.0 (CH), 36.6 (NCH_2), 39.3 (CH_2), 53.5 (NCH_2), 173.7 (Cq). − GC MS (EI, 70 eV); *m/z* (%): 128 [M^+ + 1] (100), 112 (51), 84 (37), 55 (15). − IR (NaCl/film): $\tilde{\nu}$ = 2964 cm^{-1} (s), 2932 (s), 2873 (m), 1693 (vs), 1492 (m), 1454 (m), 1433 (s), 1379 (w), 1270 (s).

Benzylbis(3-methyl-4-trimethylsilylbutyl)amine (15a): Obtained from two equivalents of methallyltrimethylsilane (**5a**) and one equivalent of benzylamine (**2d**) in 86% yield (1.18 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.02 (s*, 18 H), 0.41 (dd*, 2 H, ^2J = 14.7 Hz, ^3J = 8.7 Hz), 0.62 (dd*, 2 H, ^2J = 14.7 Hz, ^3J = 5.3 Hz), 0.89 (d*, 6 H, ^3J = 6.4 Hz), 1.37 (m, 2 H), 1.49 (m, 2 H), 1.65 (m, 2 H), 2.44 (m, 4 H), 3.56 (m, 2 H), 7.22−7.43 (5 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = −0.5 (CH_3), 23.0 (CH_3), 23.1 (CH_3), 25.4 (2 CH_2), 27.9 (CH), 37.6 (CH_2), 37.7 (CH_2), 51.8 (CH_2), 58.6 (CH_2), 126.6 (CH), 128.0 (CH), 128.8 (CH), 140.2 (Cq). − IR (neat): $\tilde{\nu}$ = 2954 cm^{-1} (s), 1454 (m), 1248 (s), 860 (s), 697 (s). − $C_{23}H_{45}NSi_2$ (391.8): C 70.5, H 11.6, N 3.6; found: C 70.9, H 11.2, N, 3.9.

***N*^{4}-Benzyl-2,*N*^{1}-dimethyl-*N*^{4}-[3-methyl-4-(methylphenylamino)-butyl]-*N*^{1}-phenylbutane-1,4-diamine (15b):** Obtained from two equivants of **9c** and one equivalent of benzylamine (**2d**) as an orange oil in 89% yield (2.94 g). − ^{1}H NMR (400 MHz, $CDCl_3$, 20°C): δ = 0.80 (d, ^3J = 6.0 Hz, 3 H), 0.87 (d, ^3J = 6.8 Hz, 3 H), 1.22

(m, 2 H), 1.59 (m, 2 H), 1.94 (br. s, 2 H), 2.43 (m, 4 H), 2.88 (s, 3 H), 2.90 (s, 3 H), 2.99 (m, 2 H), 3.16 (m, 2 H), 3.49 (m, 2 H), 6.65 (m, 6 H), 7.22 (m, 9 H). − ^{13}C NMR (100 MHz, $CDCl_3$, 20°C): δ = 17.7 (CH_3), 17.8 (CH_3), 30.27 (CH), 30.31 (CH), 31.8 (2 CH_2), 39.37 (NCH_3), 39.41 (NCH_3), 51.48 (NCH_2), 51.54 (NCH_2), 58.50/58.53 (NCH_2), 59.69 (NCH_2), 59.75 (NCH_2), 111.8 (4 PhH), 115.6 (2 PhH), 126.7 (PhH), 128.1 (2 PhH), 128.88 (PhH), 128.90 (PhH), 129.0 (4 PhH), 139.8 (Cq), 149.57 (Cq), 149.60 (Cq). − MS (EI, 70 eV); *m/z* (%): 457 [M^+] (12), 366 (15), 281 (27), 259 (10), 188 (55), 174 (33), 160 (13), 147 (14), 120 (100), 91 (30). − IR (NaCl/film): $\tilde{\nu}$ = 3091 cm^{-1} (w), 3060 (w), 3025 (m), 2951 (s), 2927 (s), 2868 (s), 2799 (m), 1599 (vs), 1464 (m), 1452 (m), 1373 (s), 1357 (m), 1343 (m), 992 (m), 746 (vs), 692 (s). − $C_{31}H_{43}N_3$ (457.7): calcd. C 81.3, H 9.5, N 9.2; found C 80.8, H 9.4, N 9.5.

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